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Annual subs: UK £44.99

UK subs: 0844 844 0032

Overseas subs:

Europe £65, ROW £85

Overseas subs: +44 (0)1795 592 906

LICENSING, REPRINTS, EPRINTS

Wright's Media
0800-051-8327 (Toll Free)

Printed by BGP

Distributed by Seymour Distribution
Tel: 020 7429 4001

OVERSEAS NEWSSTAND

Geraldine Grobler
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Custom PC is produced by Mr Freelance Limited, and published monthly by Dennis Publishing Ltd, 30 Cleveland Street, London W1T 4JD, a company registered in England number 1138891.

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90 PC building masterclass

Contrary to popular perception, PC building isn't just like doing a jigsaw with circuitboards, particularly if it's your first build. But don't worry, we're here to guide you through all the potential pitfalls. From installing a liquid cooler to tidying up your cables, our guide by long-term PC builder Antony Leather will take you through the whole process from start to finish, including the right order to do each bit. By the end of it, you'll not only be able to build a whole PC from scratch, but it will also be a well-built slick machine with a neat interior.



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BEN HARDWIDGE / FROM THE EDITOR

I DON'T WANT A HOLOLENS

The HoloLens might offer a glimpse of the future of computing, but Ben Hardwidge will be amazed if Microsoft makes it work now

During one of the most excruciating presentations since Mick Fleetwood and Samantha Fox presented the Brit Awards, this month Microsoft revealed its answer to all the critics asking what Windows 10 will give them that they can't do already. It's called the HoloLens, and it requires you to don some silly-looking specs so you can change your house into a real-life 3D Windows desktop.

Despite the presenters lacking the charisma that we've come to expect from years of slick Apple launches, the HoloLens had some wow factor. As soon as Microsoft showed the potential to lay out Minecraft on your home table, my Twitter timeline was full of people saying they wanted a HoloLens right now, and comparing it to the Holodeck. But then I remembered the Windows 7 previews, when Microsoft made a big deal about its multi-touch features, with demonstrations of playing a piano on a touch-screen. Remember all those hugely successful Windows 7 multi-touch tablets that then came out and demolished the iPad? No, me neither.

Call me a cynic, but I don't think I want a HoloLens, and while it's a cool gimmick, and might offer a little glimpse of the future of computing in years to come, I'll be amazed if Microsoft manages to make it take off in the present. It's similar to the reason stereoscopic 3D TV and gaming still hasn't really taken off – it requires you to wear silly glasses, which automatically creates another stage between you and the technology.

Not only that, but it also requires you to use it in a real 3D space, presumably your home, and that instantly creates another problem. You're then not just putting on your glasses specifically to watch a film, or a VR helmet to play a game – you're expected

to put on your glasses while you're just generally mooching around the house, and I can't see people genuinely doing that to use Windows.

Like 3D TV, the principle of the HoloLens is nothing new – it's basically Microsoft's spin on augmented reality, a system for overlaying computer graphics onto your peripheral vision, which has been around for decades. Plenty of other devices enable you to use augmented reality already. It's an option on my Nintendo 3DS, for example, enabling you to watch 3D graphics unfolding on your dining table, or shoot flying spaceships with your face on them around the lounge. It all looks really cool, but after playing through all the demos, I never used it again.

Augmented reality on the 3DS is a cool novelty, but most of the top 3DS games make no use of it, and I find it difficult to believe that there's going to be a host of genuinely useful software developed for the HoloLens too.

I think the main barrier for the HoloLens is that, despite Microsoft's best efforts, Windows' main talent is still PCs and laptops – devices where you sit down in front of a screen, and that's still what Windows does best. I have a desktop PC for work and gaming, and I have an iPad for mucking about on the Internet in the lounge. I don't need or even want to be able to play Minesweeper on my fridge door – my devices with screens already do their jobs perfectly well.

That's not to say that augmented reality won't play a part in the future of computing; I very much suspect that it will play a massive part in it. The main problem for the HoloLens is that it has Microsoft behind it, and I no longer trust Microsoft not to make a bodge of it. **GPC**

Remember those hugely successful Windows 7 tablets that demolished the iPad? No, me neither

Ben Hardwidge is the editor of Custom PC. He likes PCs, heavy metal, real ale and Warhammer 40,000. editor@custompcmag.org.uk [@mandogfish](https://twitter.com/mandogfish)

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TRACY KING / SCEPTICAL ANALYSIS

ARTIFICIAL INTELLIGENCE IS ARTIFICIAL

Despite media reports, Mario hasn't become self aware, says Tracy King

After Isaac Asimov wrote his 'three laws of robotics' in the 1940s, he realised that the rule set (no hurting humans; always obey orders unless it would hurt humans; protect yourself unless it would hurt humans) was too limited and easily exploitable. He refined and expanded the laws, as did other science fiction authors, but no one has yet been able to get around the tricky issue of definitions.

There's always a loophole, because rules require definitions, and definitions are rarely finite. 'No harming a human being' requires a caveat-free definition of both 'harm' and 'human being'. A robot delivering chemotherapy is harming a human being for the human's greater good, and by a strict interpretation of the laws, may merrily eliminate non-human organisms (say, plankton), which our species requires to survive, simply by being ignorant of the repercussions.

The ethics minefield of AI is only recently beginning to be a serious real-world domestic issue. Self-driving cars are here, with the darkly fascinating question of 'what does the car do if it's about to fatally collide with a school bus?

Kill its passenger to save the kids, or vice versa?' Although the application is new, it isn't a new dilemma. 'The trolley problem is an old ethics thought experiment that asks whether you would pull a lever to divert a runaway trolley to save five people but kill one, or do nothing and let the trolley kill the five people, which happens to save the one. The difference between this thought experiment and the driverless car, however, is that the car's on-board computer doesn't have a conscience. There are no consequences of action or inaction to the car.

That's where artificial intelligence and human intelligence part ways dramatically. We have feelings; robots don't. You can,

with sufficient syntax, emulate the expression of feelings, but no one has managed to create a robot that's actually happy. Just one that says it's happy in response to certain conditions or stimuli. But what's the difference, really? Take, as example, the recent project by researchers at the University of Tübingen in Germany in which Mario (yes, that Mario) was programmed with basic learning AI. Widely misreported by the media as 'Mario becomes self-aware' (he has become no such thing), the little plumber can navigate his surroundings (Super Mario World) by himself, learning about his environment and the consequences of his actions as he goes.

The Mario in the experiment is programmed to express states of 'happiness' but you could replace the word 'happy' in his vocabulary with 'cheesy' and nothing would change. He'd just declare he's feeling a lot cheesier as the result of an action. I asked Professor Alan Winfield, a robotics and AI ethics expert at Bristol University, for his thoughts. 'Some aspects are very interesting,' he says, 'especially the application of the refference principle, and the learning of action

sequences. But I'm much less convinced by the emotive states. It's too easy to create a variable in a computer program and label it "happiness", then when the value of that variable is reduced Mario reports "not feeling so good". This gives the false impression that Mario has feelings.'

Mario may not have feelings, but we don't particularly need AI to be influenced by the heart anyway. The self-driving cars will probably have to prioritise saving their owners over any other people (or else we may not want to buy them), and by the time AI is that sophisticated, we'll probably all be riding genetically modified Yoshis. **GFC**

A robot delivering chemotherapy is harming a human for their greater good

Gamer and science enthusiast Tracy King dissects the evidence and statistics behind popular media stories surrounding tech and gaming [@tkingdoll](#)

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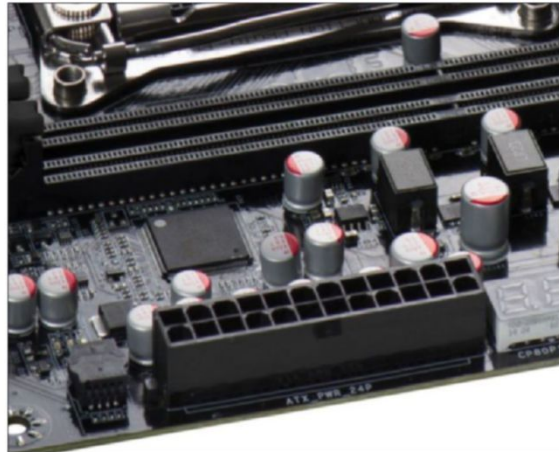
More angled connectors please

I was intrigued by your recent articles and letters, which show that modern PCs seem to be stuck in a rut (black cases, DIMMs and so on). This all started me thinking – are there other areas of the PC design that readers would like to see improved? For example, it's common to see motherboards with SATA connectors angled at 90 degrees, but why can't the 24-pin power connector also be angled in the same way. Or, for that matter, why not angle all the motherboard connectors at 90 degrees, or even mount them on the underside of the motherboard so you can't see them at all.

Also, why do we have power connectors on graphics cards in the most unsightly and inaccessible position. These sockets could be mounted on the short side of the graphics card close to the motherboard. Even better, why not incorporate the power connector into an extended PCI-E slot with sufficient capacity to power the hungriest of graphics cards – the PSU connection for it could then be positioned on the edge of the motherboard. Maybe other readers could suggest improvements to the design of the modern PC too.

MARK GARDNER

Ben: I'm sure there are plenty of areas of the PC where the standard design could be improved, but manufacturers will always have to consider whether those changes will appeal to the majority of people, or only a small minority. Putting PCI-E power connectors under the graphics card, and motherboard connectors under the motherboard, might be great for building a tidy system, but they'll



Sadly, making an angled 24-pin ATX power socket is much more complicated than making an angled SATA port

present serious problems for the average person when it comes to upgrading their PC. Imagine that your SATA data cable comes loose, for example, and you need to plug it back into the port – if it's underneath the motherboard, you'll then have to dismantle your PC and remove your motherboard just to perform a routine maintenance task.

I really like your idea about having more angled connectors, though, and it isn't the first time it's been suggested either. Around four years ago, we organised a tech summit with Asus, and asked our readers to pose some design

suggestions to Asus, one of which was an angled ATX power socket.

Asus' response was that the ATX power socket needs to be very sturdy, as it requires a fair amount of force to plug and unplug the 24-pin connector securely, and that making an angled connector requires you to add another stage between the socket and the motherboard with an angled connector, which simply wouldn't be secure enough.



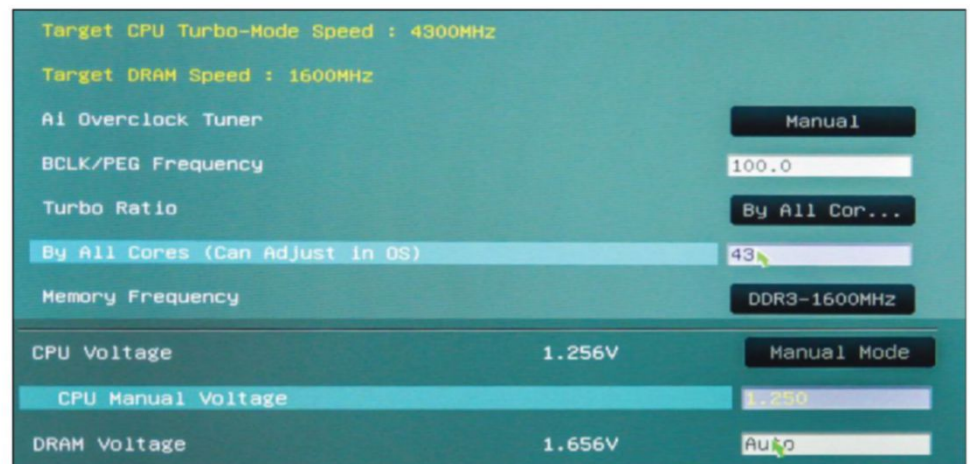
Illegible settings

Hi, I bought Issue 137 recently, the overclock settings for the i5-2500K are totally illegible – care to let me know what they are please?

DANA BERKMEN (VIA FACEBOOK)

Ben: Yes, for some reason the text in the images on that page is illegible in some copies of the magazine, for which I wholeheartedly apologise – it probably doesn't help that we made the EFI screenshots quite small throughout the whole feature so we could squeeze them all in, although the ones on the next spread have legible text, even if it's a little small. To answer your question, though, most of the settings

Our 4.3GHz overclock settings for the Core i5-2500K in full view



Why do we have power connectors on graphics cards in the most unsightly and inaccessible

in the screenshot are listed in the text above it – a total frequency of 4.3GHz, using a 1.25V vcore – you just need to set a 100MHz base clock and a 43x multiplier. We've blown up the screenshot here so you can see the settings properly.



PC buying timeline

I have an idea for a (possibly monthly) feature, and thought I'd mention it. How about a PC buying timeline? For example, I'm planning on buying a new PC in April, but I don't mind getting it plus or minus three months from that date. I'd be interested to know whether it would be worth getting it now or waiting. Obviously, the new GTX cards have just come out, but is there anything coming in the next six months that might trump them and make it worth the wait?

The same applies to processors, as I believe Intel has some funky new CPUs coming in the second half of 2015. There are also prices to consider, as I know RAM costs are rising, so is it better to buy it now, or will prices go down?

I just think it would be useful to see this timeline by component on a rolling basis, so that people know whether they should just take the plunge and buy their PC parts now, or hold off for a little while for a better or cheaper product.

MATT BASSETT

Ben: I love the idea in theory, but sadly, it would be impossible for us to implement in practice. Firstly, while we usually have knowledge of forthcoming products a few weeks in advance of the

launch, we're under strict embargo rules to not mention any of this knowledge in print – if we break the embargo, we get sanctioned with no access to review samples, and not getting information from the manufacturer. I broke an embargo on a new Intel CPU once, and didn't receive anything from Intel for six months.

Secondly, products are often delayed and reworked, so the advance information isn't always accurate anyway. A few years ago, we started

greying out parts of the Elite list if we knew a new product would be coming along, but we ended up with some months where half the Elite list was greyed out, and the forthcoming products were then delayed anyway. My best advice is to look at previous release strategies, and make an educated guess. For example, Intel usually has a tick-tock CPU release strategy, with a new architecture one year (the tick), followed by a revised version of that architecture the next year (the tock). Also, AMD's current GPU line-up has already been out a while, and Nvidia has just released a new GPU architecture, so AMD will need to be able to compete at the high end. As such, you can safely guess that AMD will be releasing some new GPUs in the near future too. **GPC**



Twitter highlights

Follow us on Twitter at @CustomPCmag

MylesHSG Sneaky change to Elite list between Issues 137 and 138. Tut tut :)



Ben: Yeah, sorry, we had to do it at the last minute – the SilverStone was taken off the market and was no longer available anywhere.

Kerrrash Nice to see the folks at @CustomPCMag understand what @EliteDangerous is all about :)

Ben: Thank you! I hope you enjoy Rick's feature about it this month too.

VPWeather Great article on making a PSU Section Cover. Keep up the great work. #CustomPC Issue No. 138.

kajun_cheng Really enjoyed your latest issue of Custom PC. Can't wait for the next issue!

tommystar101 Thank you for creating one of the best PC mags around #thebest #pcgeekatheart

Ben: Aw, thank you. We've had loads of good feedback about the last issue – glad to hear we're giving all our readers what they want.

BoltIndustrial This is a mistake right, you're never this generous!

Ben: Argh!



HexGearUK Thank you to @CustomPCMag for featuring @HexGearUK in issue 138! We are both honoured.

GravitySmacked If you bring retro tech back, and you should, you could do one on the humble acoustic coupler and bulletin boards.

Ben: I'm still in two minds about bringing back retro tech, but I've had a few requests to bring it back, so it may happen yet.

I do remember hooking up to bulletin boards in the late 1980s with my (massive) Amstrad 2,400bps modem though – it was slow and expensive to use, but exciting – the start of something new!

WHEN'S THE NEXT MAG COMING OUT?

Issue 140 of Custom PC will be on sale on Thursday, 12 March, with subscribers receiving it a few days beforehand. Visit <http://tinyurl.com/CPCDates> to see the release dates for the rest of the year.

Send your feedback and correspondence to letters@custompcmag.org.uk

Incoming

We take a look at the latest newly announced products

Deepcool shows off mini-ITX marvels

Rather than lazily knocking out another black cube, Deepcool has bucked the trend with its latest mini-ITX cases. By thinking about case design differently, and making good use of extension cables, the company has created two very interesting designs. First off is the Tristellar, which is divided into three sections, one of which

accommodates a mini-ITX motherboard along with two 3.5in bays. Meanwhile, the graphics card is held in another compartment, thanks to a PCI-E extension cable, and this section can also play home to three 2.5in drives. Finally, the third section can accommodate a 180mm PSU, along with a slimline optical drive and two 3.5in drives.

Then there's the Pentower, which looks a little like Apple's current Mac Pro design. Again, the unique

shape is achieved by separating the motherboard from the graphics card, and placing them at opposite ends via a PCI-E extension cable.



Corsair introduces new cooling kit

Corsair has just unveiled some new cooling kit, including a top-end dual 140mm liquid cooler. The Hydro H110i GT features two 140mm fans and a radiator with a width of 322mm. Along with the new radiator design, the H110i GT also shows off Corsair's new waterblock/pump design, with a customisable light-up logo. The H110i GT is also compatible with Corsair's Link system.

Also new to the Corsair stable is the Nvidia equivalent of the HG10 GPU-cooling bracket for AMD cards that we reviewed last year. The HG10 N780 is compatible with reference Nvidia GeForce GTX 780 Ti, 780, 770, and Titan and Titan Black cards. The Corsair H110i is available from www.scan.co.uk now for £100 inc VAT, while the HG10 N780 has a recommended retail price of £26 inc VAT.



Arctic launches passive GPU cooler

Arctic has just launched a new GPU cooler for people who prioritise silent operation over raw performance. The Accelero S3 has a completely passive design, based on three large heatpipes going through several heatsink fins, while a backplate disperses heat from VRMs and memory chips on the back of the board.

According to Arctic, the Accelero S3 can passively cool a GeForce GTX 660 or Radeon R7-260X without breaking a sweat, while an optional fan upgrade enables it to cool a GPU with a TDP of up to 200W. The Accelero S3 is available from www.amazon.co.uk now for £35 inc VAT.



Creative announces £400 Sound Blaster

With its eye firmly on the lucrative premium audio market, Creative has just announced a pearl white special edition of its X7 external Sound Blaster, with a price of £400. It isn't just the colour that's changed though. Unlike the standard X7, the limited edition also has a 144W (rather than 70W) power adaptor, and its headphone amplifier has an impedance of 1 ohm.

According to Creative, the new power adaptor enables the device to take full advantage of the Texas Instruments TPA3116D2 Class-D amplifier inside the device, so you can hook it up to proper hi-fi speakers without needing a hi-fi amp. The pearl white X7 also has a Burr-Brown PCM1794 DAC, and is available now from <http://uk.creative.com>





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Reviews

Our in-depth analysis of the latest PC hardware



Reviewed this month

Xigmatek Loki II p17 / MSI GeForce GTX 960 Gaming 2G p18 / Asus GeForce GTX 970 DirectCU Mini p20
SilverStone Fortress FT05 p24 / Asus VivoMini UN62 p26 / QNAP QGenie p30

CPU COOLER

Xigmatek Loki II / £17 inc VAT

SUPPLIER www.overclockers.co.uk / MODEL NUMBER CAC-S9HH3-U07

Not everyone has the money or the need to fork out the money required for an all-in-one liquid cooler for their CPU, and in many cases, a cheap and cheerful third-party air cooler will do the job fine. At £17, Xigmatek's Loki II is one of the cheapest CPU coolers we've ever tested, retailing for the same price as Arctic's legendary Freezer 7 Pro.

For the money, you get a comparatively dinky cooler, which sports a standard 92mm fan that's held in place with two typically fiddly wire clips. Thankfully, Xigmatek has applied its traditional orange and black colour scheme, so the Loki II certainly isn't dull-

looking. The heatsink is well made too, if on the small side, and its height of just 134mm means it can fit in a number of cases where clearance is an issue.

The aluminium heatsink fins sit in a fairly dense stack with rolled edges to direct airflow. Three 6mm heatpipes pass through these fins before making direct contact with the CPU heatspreader, which is surrounded by an aluminium mounting plate. There are some noticeable gaps between the heatpipes and mounting plate though.

Xigmatek states that the cooler can cope with a maximum CPU TDP of 130W, which should be enough to handle moderate overlocks on CPUs such as Intel's 88W TDP Core i7-4790K. It rightly cuts LGA2011 from its list of supported CPU sockets, though, as it's unlikely to

cope, but it's compatible with AMD's current sockets.

We were surprised to see a full-fat mounting mechanism in the box, as most other coolers at this price use pushpins. Sadly, pushpins might have been a better option, though, as the mounting system has lots of parts, and installation is fiddly too – you'll have a much easier time if you remove your motherboard before installation.

Dealing with our Core i7-4790K overclocked to 4.4GHz, the Loki II got pretty hot under the collar when the CPU was

fully loaded and, after a few minutes, the CPU actually started to throttle. Comparatively, the £26 SilverStone Argon AR01 cooled our CPU to 59°C, so the throttling was a little surprising, even though the Loki II is small. We then tried some different thermal paste (Gelid GC Extreme), which dramatically improved the situation by reducing the temperature by 6°C to a delta T of 76°C, although this temperature was still only just passable, and the fan became quite noisy too.



We were surprised to see a full-fat mounting system in the box

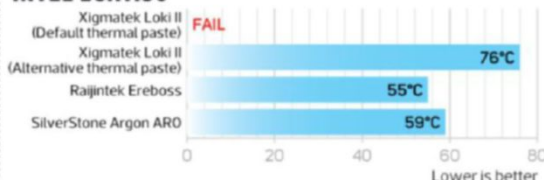


Conclusion

Despite failing to handle our overclocked test CPU out of the box, the Loki II is still miles better than a stock Intel cooler, and would be fine dealing with non-overclocked CPUs. Sadly, though, it will struggle to cope with modern overclocked quad-core Ivy Bridge and Haswell CPUs, and the included thermal paste is shoddy. It's quite loud under load as well, so we only recommend using it for non-overclocked, height-restricted systems. For everyone else, spend the extra £9 to buy the SilverStone Argon AR01.

ANTONY LEATHER

INTEL LGA1150



COOLING

18/40

DESIGN

22/30

VALUE

23/30

OVERALL SCORE

63%

VERDICT

Cheap and good-looking, but unable to cope with our overclocked test CPU. Unless you're building a low-power, height-restricted rig, buy the SilverStone AR01.

/SPECIFICATIONS

Compatibility Intel: LGA115x, LGA1366, LGA775; AMD: Socket AM3+, AM3, AM2+, AM2, FM2+, FM2, FM1

Heatsink size (mm) 92 x 50 x 134 (W x D x H)

Fans 1 x 92mm

Stated noise 20-28dB(A)

GRAPHICS CARD

MSI GeForce GTX 960 Gaming 2G / **£170** inc VATSUPPLIER www.ebuyer.com

The GTX 960 sees Nvidia finally bringing its Maxwell architecture to the all-important mid-range market. It replaces GTX 760, but it's designed more as an upgrade for GTX 660 and GTX 560 users, which still make up a large portion of the market. The GTX 960 starts at £160, and MSI's card is one of the cheaper models at £170. It mainly competes with AMD's R9 285 (£175) and R9 280 (£150).

The GTX 960 uses GM206, a new 28nm, 2.94 billion-transistor GPU with a 227mm² die. It's equipped with eight Maxwell streaming multiprocessors (SMMs) split evenly across two GPCs for a total of 1,024 stream processors and 64 texture units. By comparison, the GTX 660 has 960 stream processors and the GTX 760 actually has more (1,152), but the new, streamlined SMM design means each stream processor does approximately 1.4 times more work than those in an equivalent Kepler GPU. The GTX 960 has a reference base clock of 1,127MHz (boost 1,178MHz), but MSI has overclocked it to 1,216MHz (boost 1,279MHz).

With just two memory controllers, the GTX 960's memory interface is narrow at 128-bit, and its 2GB frame buffer is small as well – AMD's competing cards have at least 256-bit interfaces and some have

3GB of GDDR5. However, Nvidia has ways of negating the impact of its relatively low-spec memory system. Firstly, it uses a large 1MB L2 cache, reducing calls to main memory. It also uses fast (7GHz effective) memory.

However, this setup still only provides a total memory bandwidth of 112GB/sec (compared to 192GB/sec on the GTX 760 and 176GB/sec on the R9 285). As such, Nvidia also employs its third-generation delta colour compression technology, which reduces the bytes needed per frame by

around 25 per cent on average. However, this system relies on the data being lossless-compressible, which won't always be the case – there are definitely some valid concerns about the longevity of the GTX 960, as games are being developed with ever higher resolution textures. Rounding out the specs is a set of 32 ROPs, meaning the back end of the GPU shouldn't be a bottleneck, even at 2,560 x 1,440.

Maxwell's efficiency is immediately obvious, as the GTX 960 requires just one 6-pin PCI-E power connection. MSI has upgraded it to an 8-pin socket, potentially providing more power for overclocking, but also includes an adaptor for 6-pin cables so people with older PSUs can still use it.



The card has ample display connections, with HDMI 2 support being a first for this market segment. The GTX 960 can support up to 5K resolutions too, and up to four 4K MST displays. The GTX 960's dedicated encode/decode hardware block (NVENC) now offers full encode and decode for H.265 content as well, which is good news for budding HTPC owners. Naturally, G-Sync is fully supported, as are other graphics rendering and display technologies introduced with the GTX 980, such as MFAA and DSR.

Meanwhile, MSI's Twin Frozr V cooler is very large, measuring 270mm long and being around 30mm taller than an expansion slot bracket. It has an open, plastic shroud, meaning hot air will mostly be exhausted into your case. Heat is drawn away from the GPU via a baseplate and three nickel-plated copper heatpipes, and then dispersed by two large downdraft fans, which will switch off entirely if the core temperature is low enough.

MSI uses its Military Class 4 components in the 4+1 phase power system, with the MOSFETs also cooled by their own small heatsink. The memory chips, however, aren't directly cooled.

Performance

By and large, you'll have the same experience on a GTX 970 as a GTX 760 – MSI's card is only 5 per cent faster than a 760 on average, even with its overclock. The GTX 960 has less of an advantage at 2,560 x 1,440 too, where the GTX 760 actually beats it in Crysis 3, suggesting that the narrow memory interface and 2GB frame buffer could be limiting it in situations with very high-resolution textures. There isn't much between the two GPUs in Battlefield 4, although the GTX 960 is slightly quicker in BioShock: Infinite.

Next to the GTX 660, however, the new GPU has a lot more horsepower, with MSI's here being 35 per cent quicker on average. In Battlefield 4 and Crysis 3, it jumps from around 30 to 40 at 1080p. Meanwhile, in BioShock Infinite, it's comfortably above 60 at 1080p and 30 at 2,560 x 1,440 – both targets that the GTX 660 fails to meet.

Against AMD hardware, it isn't so good. Again, we're talking small differences, but the R9 280 beats it in

The 960 needs just one 6-pin power connector

/SPECIFICATIONS

Graphics processor Nvidia GeForce GTX 960, 1,216MHz (boost 1,279MHz)

Pipeline 1,024 stream processors, 64 texture units, 32 ROPs

Memory 2GB GDDR5, 7GHz effective

Bandwidth 112GB/sec

Compatibility DirectX 12, OpenGL 4.5,

Outputs/inputs 3 x DisplayPort, dual-link DVI-I, HDMI

Power connections 1 x 8-pin, top-mounted

Size 270mm long, dual-slot

Battlefield 4. The MSI GTX 960 has no particular advantage over the R9 280 or R9 285 in BioShock Infinite either, and although it manages the top spot in Crysis 3 at 1080p, it loses to both AMD GPUs at 2,560 x 1,440. To be fair, though, none of these GPUs achieved a playable frame rate in Crysis 3 at this resolution anyway.

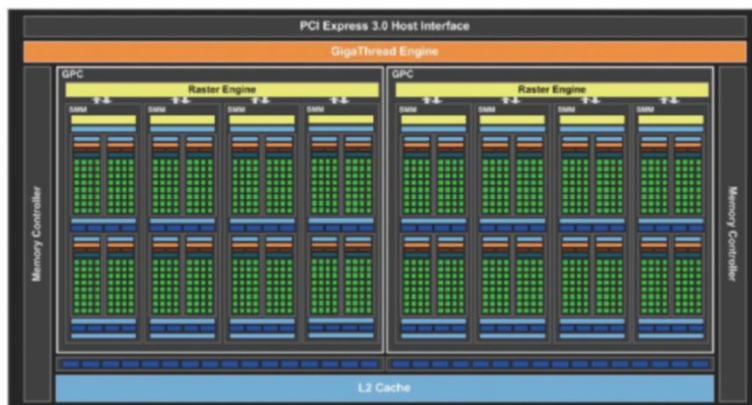
One factor that's undeniable, though, is the GTX 960's efficiency – this overclocked card consumes just 10W more than a GTX 660 and significantly less than the GTX 760, R9 280 and R9 285.

This efficiency translates into low temperatures and, thanks to the Twin Frozr V cooler, extremely low noise – it's one of the quietest cards we've ever heard, with the fans reaching just 35 per cent speed (well under 1,000rpm) under load.

Overclocking also proved fruitful. We took the core to 1,345MHz (1,417MHz boost) and it boosted happily to over 1,520MHz. This 14 per cent overclock was paired with an 11 per cent overclock on the memory, which reached 7.8GHz (effective). Improvements in tests ranged from 10 to 14 per cent as a result, with only 12W more power consumed and no extra noise.

Conclusion

If you're seeking a new graphics card purely to get the best raw gaming performance possible for your sub-£200



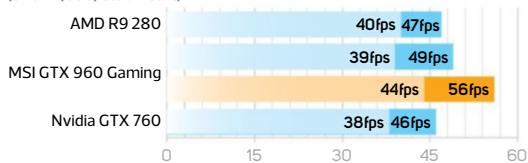
budget, then AMD's mid-range Radeon hardware is a better bet at the moment, with all of its closest competing cards having more memory bandwidth too. However, if you want a mid-range card for a small form factor build, the GTX 960's efficiency makes it well suited.

In terms of MSI's card, it could easily be smaller, but the cooler is undeniably excellent. If you're looking for a power-efficient, quiet mid-range graphics card, the MSI GeForce GTX 960 Gaming 2G is great, but you'll get more performance for your money with AMD's current mid-range GPU hardware.

MATTHEW LAMBERT

BATTLEFIELD 4

1,920 x 1,080, Ultra Detail, 4x AA



2,560 x 1,440, Ultra Detail, 4x AA



BIOSHOCK INFINITE

1,920 x 1,080, Ultra Detail with Depth of Field



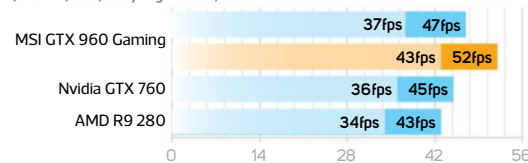
2,560 x 1,440, Ultra Detail with Depth of Field



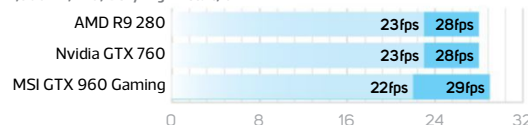
Stock speed min Stock speed avg Overclocked min Overclocked avg

CRYSIS 3

1,920 x 1,080, Very High Detail, 0x AA

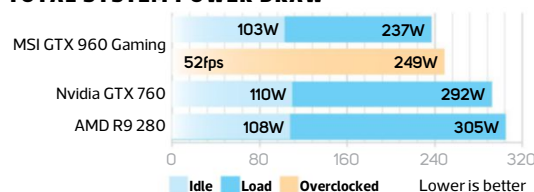


2,560 x 1,440, Very High Detail, 0x AA



Stock speed min Stock speed avg Overclocked min Overclocked avg

TOTAL SYSTEM POWER DRAW



Idle Load Overclocked Lower is better

SPEED
30/40
VALUE
31/40
FEATURES
19/20

OVERALL SCORE
80%

VERDICT

A quiet and very power-efficient GTX 960, but Nvidia's new mid-range hardware could be more competitive on the price-performance front.

GRAPHICS CARD

Asus GeForce GTX 970 DirectCU Mini / £282 inc VAT

SUPPLIER www.overclockers.co.uk

While the GTX 970 and GTX 980 undoubtedly deliver on performance, Maxwell is really all about efficiency. Efficient computing means less power consumption and heat output, while still maintaining decent performance. In turn, you can then manage this heat with less bulky and quieter coolers. With its GTX 970 DirectCU Mini, Asus has fully taken advantage of Maxwell's efficiency, offering one of the world's most powerful GPUs in a dual-slot card that's just 170mm long – the same length as a mini-ITX motherboard.

Thankfully, diminished size doesn't equal diminished build quality. The card comes complete with a lovely metal backplate; it doesn't offer any direct cooling to components, but it looks better through a window than a bare PCB, and it will still dissipate some heat. The main cooler shroud is formed from plastic, but it's neither loose nor flimsy.

Meanwhile, the rear I/O panel uses the older Nvidia selection of ports (an extra DVI connection instead of two extra DisplayPort sockets), but it's still well equipped and includes HDMI 2. Along the top edge you'll find a single 8-pin PCI-E power connector, with a small LED that

changes from red to white to let you know you've successfully connected it. There are also two SLI connectors, although we doubt that many people will be using this card in SLI mode – it's all about getting the most out of a mini-ITX board's single slot.

Asus has even managed to squeeze a factory overclock onto the card, taking the base clock from 1,050MHz to 1,089MHz (1,228MHz boost). It's only a 4 per cent increase, but it's still good to see any overclock on such a small card, although the memory has been left at the stock frequency of 7GHz – you can't have it all. We've seen heavier factory overclocks from both MSI and Galax, but those cards are significantly larger too.

A copper vapour chamber cools the GPU, and a circular array of fins are soldered to this chamber, linking it to an additional metal contact plate that has thermal pads to link it to the vital power circuitry (MOSFETs and VR controller) and the memory chips, although bizarrely only four of the eight dies are directly cooled. Still, there's clearly a lot of heat being transferred through the DirectCU Mini cooler. On top of the fins is the Asus CoolTech fan, which has



an inner radial fan section with outer curved blades, and is designed to push air through the cooler in as many directions as possible while staying quiet. It doesn't have a semi-passive mode, and exhausts air in all directions through the open sides of the cooler shroud.

Finally, a look at the PCB reveals very efficient use of space. There's a 4+1 phase power arrangement, for which Asus uses its Super Alloy Power components, which Asus claims offer increased efficiency, less buzzing noise and a longer lifespan. At the time of writing, there's no waterblock that fits the PCB of this card, which is a shame, as it would be great to see a water-cooled mini-ITX build using this card and the Asus Maximus VII Impact. Hopefully, a manufacturer will seize the opportunity soon.

Performance

The 970 Mini's performance is right where you'd expect it – a few frames per second off the speed of the Galax and MSI GTX 970 cards, which ship with heftier overclocks. You'd be very hard-pressed to notice this difference in actual gameplay though. At 2,560 x 1,440p, in both Battlefield 4 and Crysis 3, the Asus runs comfortably above 30fps with maximum detail (albeit without anti-aliasing in Crysis 3). With average frame rates of around 40–50fps in these games, the card is ripe for use with a G-Sync screen too. In both of these demanding games, the card is unsuitable for 4K, although you can say the same for any current single-GPU card – even the GTX 980 can't maintain 20fps in Crysis 3.

BioShock Infinite is our easier test, and the GTX 970 again excels. The Galax and MSI cards, with their higher boosting, have slightly higher frame rates, but the mini Asus card is close behind, with its minimum frame rate never dropping below 60fps at 2,560 x 1,440, and staying at over 30fps at 4K.

The card's efficiency is also unrivalled. The MSI and Galax cards consume more power than a stock-speed GTX 980, thanks to their high

The PCB reveals very efficient use of space

/SPECIFICATIONS

Graphics processor Nvidia GeForce GTX 970, 1,089MHz (boost 1,228MHz)

Pipeline 1,664 stream processors, 64 ROPs

Memory 4GB GDDR5, 7GHz effective

Bandwidth 224GB/sec

Compatibility DirectX 12, OpenGL 4.5

Outputs/inputs Dual-link DVI-D, Dual-link DVI-I, HDMI, DisplayPort

Power connections 1x 8-pin, top-mounted

Size 170mm long, dual-slot



factory overlocks, but with a lower overclock, a single 8-pin header, one fan and smaller power delivery system with efficient components, our entire system drew 264W with the Asus card installed, compared to 409W with a Radeon R9 290X and 309W with the MSI GTX 970.

Overclocking netted some excellent results too. We achieved a whopping 20 per cent overclock, adding 220MHz for a base clock of 1,309MHz. This frequency gave us a boost clock of 1,448MHz, which the Asus card easily hit, sometimes even reaching 1,500MHz or higher. We easily pushed the memory up to 7.8GHz (effective) too.

In our overclocked tests, we see performance improvements of between 13 and 16 per cent, where the Asus closes the gap on MSI and Galax. These two cards are still a touch faster when also overclocked, but the smaller dimensions, power circuitry and cooler certainly don't appear to be a significant limit on overclocking in this case. There was also no extra noise or much of a temperature increase after overclocking either, and system power consumption amazingly stayed below 300W.

Conclusion

Asus has embraced the efficiency of Maxwell to create a true pocket rocket that's the perfect companion for a mini-ITX powerhouse. It offers a tremendous amount of power in a small space, and it doesn't suffer for it either. It might not

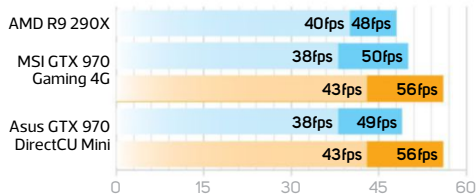


have a semi-passive mode, but the Asus card still runs quiet and cool, and it overclocks like a champ too. Achieving this feat with the competing AMD R9 290 and R9 290X simply isn't possible. If you want to squeeze a fast graphics card into a mini-ITX system, the Asus GeForce GTX 970 DirectCU Mini is the perfect card for the job.

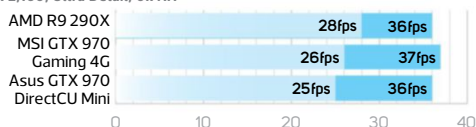
MATTHEW LAMBERT

BATTLEFIELD 4

2,560 x 1,440, Ultra Detail, 4x AA



3,840 x 2,160, Ultra Detail, 0x AA



BIOSHOCK INFINITE

2,560 x 1,440, Ultra Detail with Depth of Field



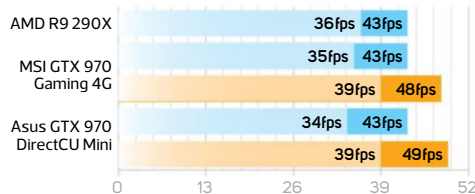
3,840 x 2,160, Ultra Detail with Depth of Field, AA off



Stock speed min Stock speed avg Overclocked min Overclocked avg

CRYSIS 3

2,560 x 1,440, Very High detail, 0x AA

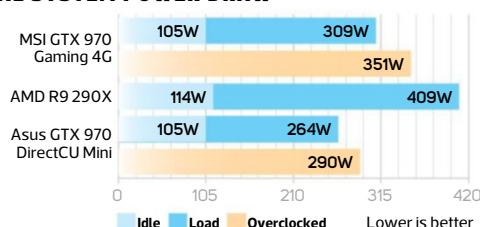


3,840 x 2,160, Very High detail, 0x AA



Stock speed min Stock speed avg Overclocked min Overclocked avg

TOTAL SYSTEM POWER DRAW



Idle Load Overclocked Lower is better

SPEED
37/40

FEATURES
18/20

VALUE
35/40

OVERALL SCORE
90%

VERDICT

A fantastic card that takes full advantage of Maxwell's efficiency to deliver outstanding power in a dinky body – it's a mini-ITX builder's new best friend.



Minerva

"Under a grand nets you a system that is powerful enough to use in any gaming title you care to play..."

Bryan Water, OC3D.net

- Overclocked Intel® Core™ i5-4690K Quad Core
- Windows 8.1
- 16GB HyperX DDR3 FURY 1600MHz
- 120GB HyperX 3K SSD
- 2TB 7,200RPM HDD
- 4GB NVIDIA® GeForce® GTX 970
- 3 Year Standard Warranty

from
£999*



Vortex 440

"a true winner of a system; offering great value for money, epic all-round performance and superior build quality."

Ryan Martin, eTeknix.com

- Intel® Core™ Six Core i7-5820K CPU
- Windows 8.1
- 16GB HyperX DDR4 Predator 2400MHz
- 240GB HyperX 3K SSD
- 2TB 7,200RPM HDD
- 4GB NVIDIA® GeForce® GTX 970
- 3 Year Standard Warranty

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Predator X99

"The Predator X99 is built to very high standards and designed for a myriad of duties including 4K"

Zardon, KitGuru.net

- Intel® Core™ Six Core i7-5820K CPU
- Windows 8.1
- 16GB HyperX DDR4 PREDATOR 2400MHz
- 240GB HyperX 3K SSD
- 2TB Seagate SSHD
- 8GB AMD Radeon™ R9 295X2
- 3 Year Standard Warranty

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Ultrabook II

"what you do get with the UltraNote II is more than just alright. It gets the job done, and does so at a reasonable price."

TechRadar.com

- 15.6" Full HD IPS Display (1920 x 1080)
- Intel® Core™ Quad Core i3-4110M CPU
- Windows 8.1
- 8GB Kingston 1600MHz
- 500GB 5,400 HDD
- Intel® HD Graphics 4600
- 3 Year Standard Warranty

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£514*



Optimus V X13

"Need a powerful 13 inch laptop? The Optimus V X13 packs a serious punch!"

Zardon, KitGuru.net

- 13.3" Full HD IPS Display (1920 x 1080)
- Intel® Core™ Quad Core i7-4710MQ CPU
- Windows 8.1
- 8GB HyperX DDR3 IMPACT 1600MHz
- 1TB Seagate SSHD
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- **Windows 8.1**
- 16GB HyperX DDR3 IMPACT 1600MHz
- 120GB HyperX V300 SSD
- 4GB NVIDIA® GeForce® GTX 980M
- 3 Year Standard Warranty

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3D Vision 1800 PC

This brilliant gaming PC is everything you need to play games in 3D. With a monitor and glasses included, you are set up and ready to go straight out of the box!

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- **Windows 8.1**
- 32GB HyperX DDR3 FURY 1600MHz
- 120GB HyperX 3K SSD
- 4GB NVIDIA® GeForce® GTX 980
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- Corsair 650W RM Series PSU
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ATX CASE

SilverStone Fortress FT05 / **£130** inc VATSUPPLIER www.scan.co.uk

SilverStone's Fortress series of cases has always been about having a premium aluminium exterior with an internal design that's heavily focused on supreme air-cooling abilities. Not all the latest models have been hits, but the FT02 from 2010 is still much loved. The latest version, the FT05, looks a little like a return to that chassis, as it reverts to a bottom-to-top airflow model and has a familiar, albeit smaller, external design, including a cutaway lower section for air intake.

The FT05 sports minimalist, clean aesthetics without looking boring – its sharp angles and acrylic trim around the sides and front make it far more visually striking than your average big black box. It's available in black or silver, windowed or windowless, and looks great in all four possible flavours.

Of course, it isn't just about looks; the build quality is also sublime. With thick aluminium panels used all around, it's incredibly rigid and strong, and thick rubber along the bottom provides plenty of grip. However, the rectangular mesh roof section is disappointingly made from bendy plastic, although its appearance at least blends in well with the rest of the case. It's responsible for shielding cables plugged into the motherboard's rear I/O panel, as the rotated motherboard means they emerge from the top of the chassis. It would be better if this part was a milled sheet of aluminium, although that would increase the cost.

The case's cooling power comes from two 180mm Air Penetrator fans at the bottom, which blast air upwards through your core hardware and out of the roof. The fans

have an easily removable magnetic dust filter within the cutaway section too. There's no exhaust fan, as the case relies on positive pressure for exhaust, but there's a 120mm roof mount if you want it. This mount can be used for an all-in-one liquid cooler too, and the bottom fans can be removed to make way for radiators up to 360mm long, although any radiators thicker than 25mm will eat into the available space for graphics cards. Of course, liquid cooling isn't the primary focus of the Fortress FT05, but it's great to at least have some options.

The case's front I/O panel sits at the front of the roof, shielded by a spring-loaded plastic cover. As well as the usual USB 3 and audio jacks, it also offers independent fan control sliders for the two case fans with three fixed speed settings. Meanwhile, at the rear of the FT05 you'll find a ventilated area for the PSU intake, and this area has a magnetic filter too.

The plastic roof cover slides out easily. You can then use a hidden lever and a tug to pull the side panels up and out. It's straightforward enough, but the right panel is particularly stiff.



Both side panels, as well as the front and rear ones, and the bottom of the external cutaway section, are also lined with noise-dampening foam.

As the FT05 is quite small, and its main area is free from obstruction, there are a few limitations on the hardware you can get inside it. For starters, the PSU, which hangs vertically at the back, has the case's only hard drive cage beneath it. However, if your PSU exceeds 160mm in length, this cage will need to be removed, and even using a 160mm modular PSU is a very tight fit with the cables. It definitely helps to fit a small PSU into this case if possible.

Moving behind the motherboard tray, you'll find a vertically mounted plastic bracket at the front that allows you to install a slot-loaded slimline optical drive.

There are also two SSD mounts on the back of the tray itself, and these mounts are fully usable without having to remove the motherboard.

Cable routing isn't the easiest job either, as space is really tight behind the motherboard tray. As you can only install a few drives, you'll never have masses of cabling, but it can still get quite fiddly. It isn't impossible to route your cables neatly, just time-consuming, and with a case this tasty on the outside, it's worth the trouble, especially if you opt for the windowed version for £10 extra.

Performance

We're used to seeing good performance from SilverStone's Fortress cases, and the FT05 delivers it in spades. It should come as no surprise to learn that the CPU result at full speed is one of the best we've ever seen with our current test hardware. The large Air Penetrator fans deliver swathes of focused airflow and are positioned just inches away from the CPU cooler's own fan.

/SPECIFICATIONS

Dimensions (mm) 221 x 427 x 483 (W x D x H)

Material Aluminium, steel, plastic

Available colours Black, silver

Weight 9.5kg

Front panel Power, reset, 2 x USB 3, stereo, mic

Drive bays 1 x slimline slot-loading optical, 2 x internal 3.5in, 2 x internal 2.5in

Form factor(s) SSI-CEB, ATX, micro-ATX

Cooling 2 x 180/140mm or 3 x 120mm bottom fan mounts (2 x 180mm fans included), 1 x 120mm top fan mount (fan not included)

CPU cooler clearance 162mm

Maximum graphics card length 312mm

Extras Removable dust filters, noise dampening material, 2 x three-speed fan controllers

- 1 Two 180mm Air Penetrator fans at the bottom blast air upwards
- 2 The front panel has two fan controls, as well as USB 3 ports and audio jacks
- 3 There's only one small hard drive cage, right next to the PSU mount

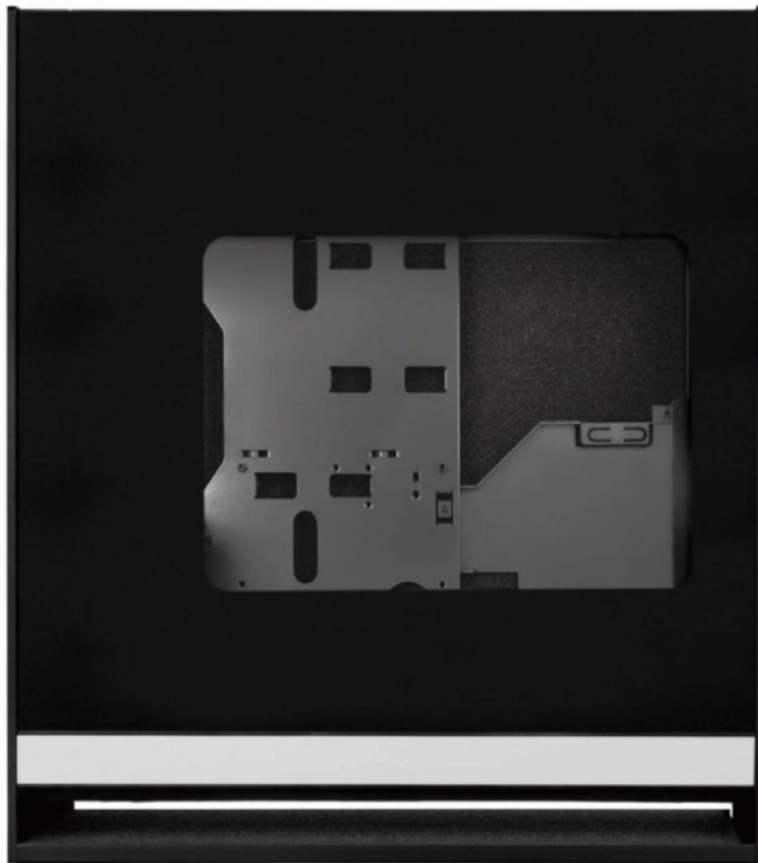


It's a very similar story for GPU cooling, with the fan now positioned right next to the graphics card's intake area, and again delivering one of the best ever results. Even better is the fact that you can go to minimum fan speed with minimal impact on the temperatures.

At this speed, the FT05 still ranks as one of the best-performing cases we've tested, and is a lot quieter than at full speed, where it can get a touch noisy. Low speed easily offers enough airflow for most systems – we can't see many people needing to go beyond medium.

Conclusion

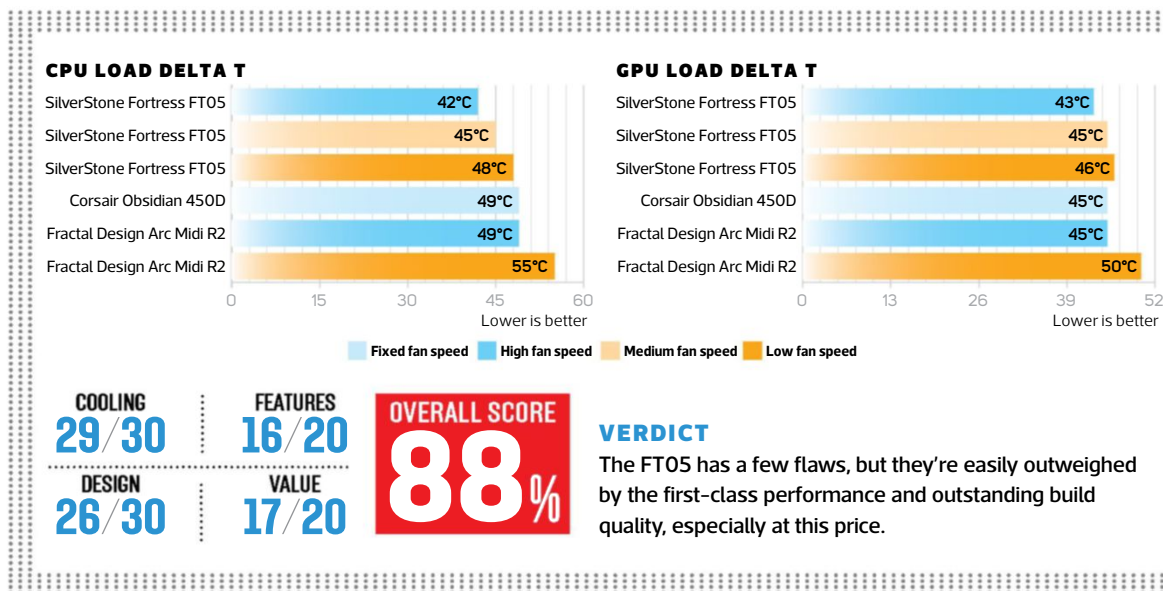
The FT05 is an absolutely cracking case. Its cooling ability is inarguably fantastic, but that isn't all it has going for it. The sleek design cuts down on the desk footprint at the expense



of some hardware, but you can still house a very powerful rig inside it, provided you're willing to take a little extra care with the cable routing. It also offers USB 3, easily removable dust filters and independent fan control.

Furthermore, build quality is excellent, but SilverStone isn't charging as much as we expected; this case costs around £50 less than its predecessor. PC builders who are serious about water cooling or require heaps of internal storage will need to look elsewhere, but for everyone else, the FT05 is a great premium chassis.

MATTHEW LAMBERT



MINI PC BARE BONES

Asus VivoMini UN62 / £277 inc VAT

SUPPLIER www.ebuyer.com / MODEL NUMBER 90MS00A1-M00190

There are plenty of ways to get a Windows PC that's even smaller than a mini-ITX rig. Intel's NUC motherboards provide Celeron, Core i3 and Core i5 integrated CPUs, and Intel has even released a USB flash drive-sized Windows 8.1 Compute Stick recently too. However, Asus has come up with its own take on the NUC with the VivoMini.

Inside, there's an MCB that looks suspiciously like a NUC board. It's the same size, and the two SODIMM memory slots and mSATA port are in roughly the same place too. However, on closer inspection, there are a few extra bits bolted on. The attractive case is peppered with ports. The front only sports an illuminated power button, but the side has two USB 3 ports, an SD card reader plus a Kensington lock, while the rear has an Ethernet port, two more USB 3 ports, a DisplayPort connector and HDMI port, as well as a DC input jack. There's also a combined microphone/headphone jack.

The VivoMini comes in two flavours. The cheaper UN42 model offers a Celeron and lacks 4K screen support, but is otherwise identical to the pricier UN62 that we're reviewing here. The latter offers more powerful Haswell-based Core i3-4030U and Core i5-4210U processors. These chips are

also slightly different to the CPUs offered in Intel's own Haswell-based NUCs. For example, the dual-core Core i5-4210U in the VivoMini UN62 is slightly faster than Intel's Core i5 NUC, as its base frequency is 400MHz higher, and its maximum turbo frequency has a 100MHz advantage too.

Both models come without an mSATA SSD and memory, like most bare bone NUCs. As such, the price of £277 will be closer to £350 once you're ready to go, although the equivalent NUC costs over £300 to start. Unlike some NUC

cases, there's no room for a 2.5in hard disk or SSD, though, so you're limited to using an mSATA drive for your operating system. You can then expand your storage using the USB 3 ports and an external hard disk. Meanwhile, the two SODIMM slots support 1.35V memory only, and you can install up to 16GB of it, although we doubt you'll need more than 8GB.

Along with its Gigabit Ethernet port, the VivoMini UN62 also includes an Azurewave AW-CB161H Wi-Fi module that offers 802.11ac and Bluetooth 4 support, and it has a built-in antenna. Also included in the box is a VESA mounting plate that allows you to connect the case to your monitor's VESA mount if it has one. Like Intel's standard NUCs, the VivoMini UN62

isn't passively cooled, and includes a small fan at the top that exhausts hot air to the rear. On the underside of the case is a small vent to allow air into the chassis, while four small rubber points lift the case off flat surfaces by 5mm.

Being made by Asus, the VivoMini UN62 also includes some of the usual software you'd see with a motherboard, such as HomeCloud and WebStorage. You can also update the EFI using a USB drive, and the EFI feels very familiar too. You can't tweak any of the frequency or voltage settings as you can on most NUCs, but overclocking isn't really a concern on such a device anyway.

Another useful feature comes in the form of USB Charger +, which provides faster device charge times from two of the VivoMini UN62's USB 3 ports.

Performance

We used 8GB of 1,600MHz DDR3 memory, along with a 120GB mSATA SSD, to test the VivoMini UN62. Sitting idle at the desktop, the power draw was incredibly low, dipping to just 8W and usually sitting at around 15W when browsing the Internet or word processing. Under full load in Prime95, it peaked at 31W – a near-identical result to an Intel Core i5-4250U-based NUC. With the processor temperature sitting at 80°C at load, the machine was also very quiet, with just a slight whine audible from a few feet away. When carrying out less demanding tasks, we couldn't hear it at all unless we put our ears right against it.

Meanwhile, in the Elder Scrolls V: Skyrim, the VivoMini UN62 needed the settings to be reduced to High settings at 720p with both AA and AF disabled in order to manage a playable minimum frame rate of 25fps, although the game didn't look too bad at these settings, despite the dialled-down eye candy. Interestingly, the Intel Core i5-4250U-based NUC was consistently slower in this test, with a minimum frame rate of 20fps.

Finally, in the Custom PC RealBench suite, the VivoMini UN62 was 10 per cent quicker than the Intel Core i5-4250U-based NUC in the image editing test, 5 per cent faster in the video encoding test and 13 per cent faster in the multi-tasking test. Its System Score of 38,588 was also much faster, with the extra clock speed helping it to a clear lead over the Core i5-4250U, which only managed 35,726.

The dual-core Core i5-4210U is slightly faster than Intel's Core i5 NUC

/SPECIFICATIONS

CPU Intel Core i5-4210U

Memory support 2 slots: max 16GB DDR3 (up to 1,600MHz)

Expansion slots 2 x SODIMM 1.35V, 1x mSATA, 1x mini PCI-E

Networking 1x Gigabit LAN, 802.11ac Wi-Fi

Ports 4 x USB 3, 1x SD card reader, 1x DisplayPort, 1x HDMI, 1x Gigabit LAN

Dimensions (mm) 131 x 131 x 42 (W x D x H)

- 1 You can install up to 16GB of 1.35V RAM in the two SODIMM slots
- 2 Both HDMI and DisplayPort connectors are provided on the rear
- 3 The Azurewave Wi-Fi module supports 802.11ac and Bluetooth 4



Conclusion

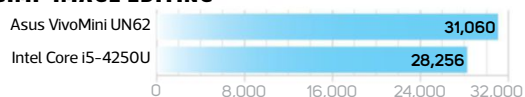
As with Intel's NUCs, the VivoMini UN62 makes for a great tiny PC. You can build a mini-ITX PC for less, of course; AMD's APUs make for a good low-priced dinky gaming rig, and even a Core i3 desktop CPU runs rings around the UN62's low-power Core i5. However, the miniscule size and very low power draw of both Asus' effort and Intel's NUCs are hard to beat if building a discreet system is your priority.

As well as being cheaper and faster than Intel's Haswell-based Core i5 NUC, the VivoMini UN62 is also extremely quiet and includes a VESA mount too. If you don't need masses of processing power, and want to save space and electricity, the VivoMini UN62 is still nippy in Windows and can just about handle some games at 720p. It's also perfect for a low-power HTPC.

ANTONY LEATHER

CUSTOM PC REALBENCH 2014

GIMP IMAGE EDITING



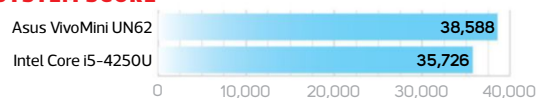
HANDBRAKE H.264 VIDEO ENCODING



HEAVY MULTI-TASKING



SYSTEM SCORE



SPEED
38/45

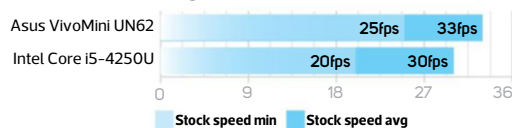
FEATURES
27/30

VALUE
23/30

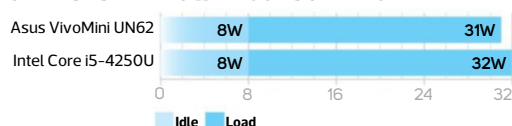
OVERALL SCORE
88%

THE ELDER SCROLLS V :SKYRIM

1,280 x 720, 0x AA, 0x AF, High detail



TOTAL SYSTEM POWER CONSUMPTION



VERDICT

You'll have little change from £350 once you've bought memory and an mSATA SSD, but the VivoMini UN62 is quiet, faster than Intel's Haswell NUCs and extremely power efficient.

/TEST KIT

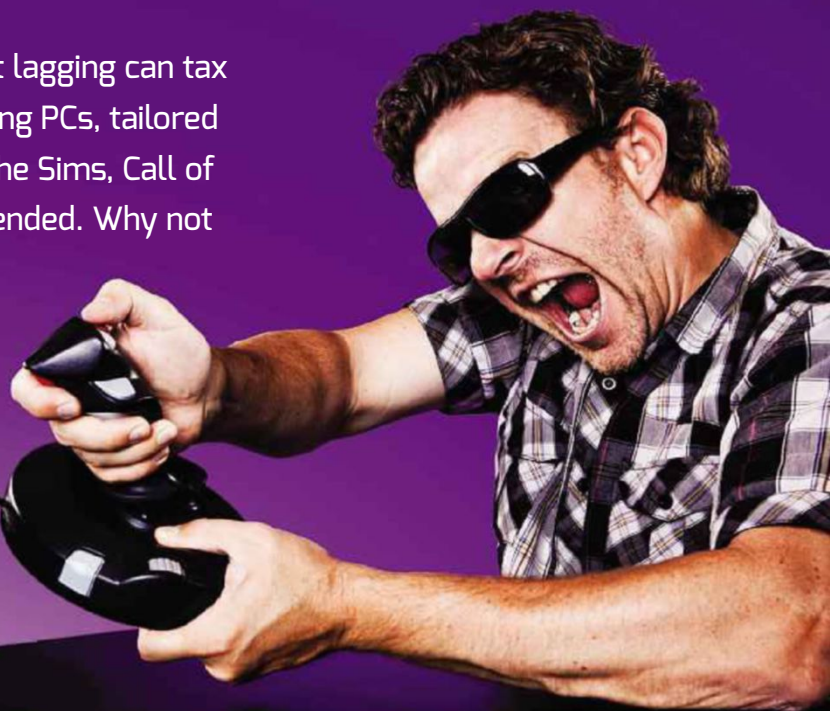
8GB Kingston 1,600MHz 1.35V DDR3 SODIMM, Kingston 120GB mSATA SSD, Windows 7 64-bit

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RAM	8GB Memory	Graphics	NVIDIA GT 850M 2GB	Network	WiFi 802.11b/g/n
Hard Drive	1TB Hard Drive	DVD	DVD+-RW Drive	OS	Windows 8.1

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Images are for illustrative purposes only.
Monitors and peripherals are available separately.
Games / Software shown as compatible are not included.



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PORTABLE NAS

QNAP QGenie / £70 inc VAT

SUPPLIER www.ebuyer.com / MODEL NUMBER QG-103N



If you're anything like ourselves here at Custom PC, you probably carry a fair few gadgets around with you, from USB flash drives to portable batteries to charge your smartphone on the move. However, NAS enclosure manufacturer QNAP has come up with the QGenie, which it says will combine all these features and more in one device.

In addition to having its own internal 30GB of speedy flash storage, the QGenie also has a built-in 3,000mAh battery. This battery powers the device itself, but it can also be used to charge your smartphone or tablet. This capacity is enough to charge most modern smartphones from flat to full, and again to around 50 per cent.

However, it's the QGenie's built-in Wi-Fi access point that makes it really interesting. If you're using a hotel Ethernet port or router, for example, you can use the QGenie to share an Internet connection wirelessly to numerous devices.

Likewise, you can also use it to broadcast a tethered

smartphone's Internet connection, or even connect a data dongle to its USB 3 port and share the connection to several devices.

QNAP has also tapped into the power of Windows, Mac OS, Android and iOS devices, allowing you to connect to the QGenie to upload from these devices to download or share files and media. If

you're running out of space for photos

on your smartphone, you can upload a wad of them to the QGenie manually or automatically.

For those long train or car journeys, you can upload videos to the QGenie to stream them to your tablet or smartphone, instead of storing them locally.

The side section also sports an SD card slot, which you can use to expand the QGenie's internal storage. What's more, you could also plug your camera's SD card into this slot to dump all your photos onto its internal flash drive – handy if you're snap-happy and regularly run out of space. The internal storage isn't SSD-fast but we measured sequential read and write speeds of 113MB/sec and 61MB/sec respectively using CrystalDiskMark. Connected to an 80Mb/sec (download) and 20Mb/sec (upload)

Internet connection through the QGenie, an iPhone 6 managed to download at 35Mb/sec and max out the upload speed, so it has enough headroom to cope with several devices streaming files at once too.

To access the QGenie and configure its various features, you can either use a browser if it's on your network, or use the Android or iOS Qfile apps. It isn't the most user-friendly device to get working, but once you're used to it, moving files and folders around is fairly painless. Thankfully, as it has its own Wi-Fi

access point and internal battery, you can connect your smartphone to it wirelessly wherever you are.

Conclusion

The QGenie can be a little tricky to set up and use at first, but £70 for a portable substantial battery back, Wi-Fi access point, NAS and 30GB of storage isn't a bad deal at all, and it's a very handy gadget to carry around. It's a shame the internal storage isn't bigger, though, as the 30GB capacity limits its use out of the box; however, it's also expandable, and it's still a handy gizmo even with just 30GB on offer.

ANTONY LEATHER

/SPECIFICATIONS

Storage capacity 30GB

Ports 100Mb/sec Ethernet, USB 3 (A) USB 3 (micro B), SD card

Wi-Fi 802.11n 150Mb/sec

Battery capacity 3,000mAh

Supported operating systems Windows, Mac OS X, iOS, Android, Linux

SPEED
30/35

FEATURES
27/35

VALUE
27/30

OVERALL SCORE
84%

VERDICT

Rather than being a jack of all trades, the QGenie masters numerous features well, making for an incredibly handy device. It could just do with some more internal storage.



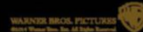
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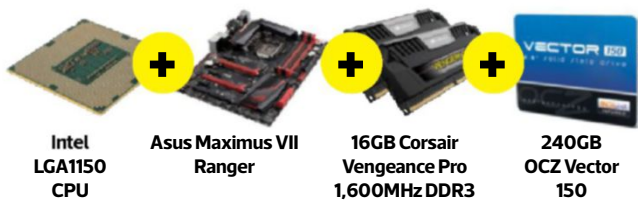
How we test

Thorough testing and research is the key to evaluating whether a product is worth buying, and deciding whether or not there's a better alternative

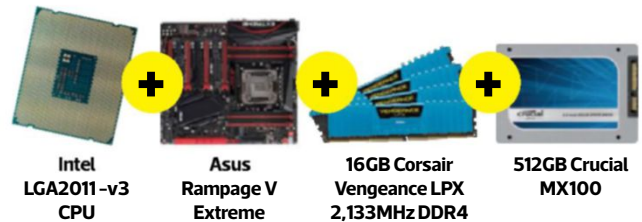
PROCESSORS

We judge CPUs on whether they offer sufficient speed for the price. Part of a CPU's speed score comes from how overclockable it is. Every type of CPU is tested in the same PC, so all results are directly comparable.

INTEL LGA1150



INTEL LGA2011-V3



AMD FM2+



COMMON COMPONENTS

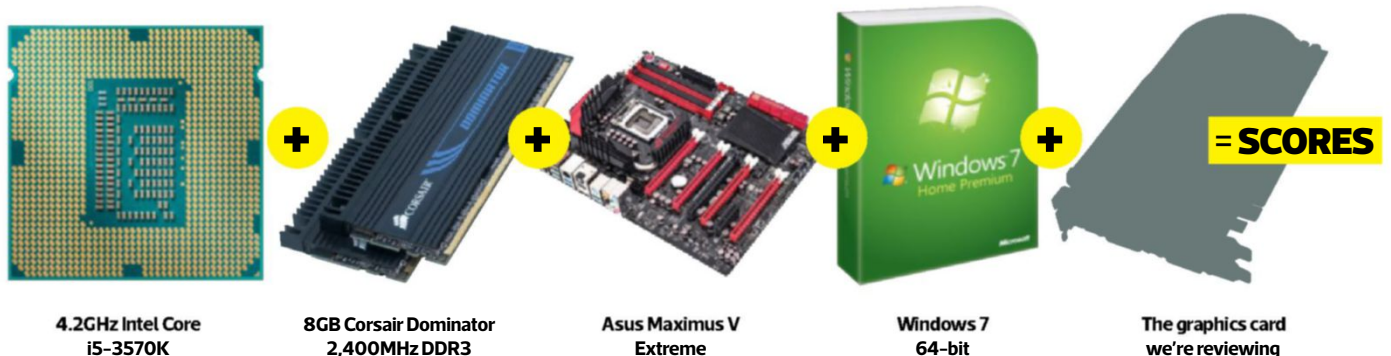


TESTS: We use the Custom PC Media Benchmarks (or CPC RealBench 2014 on LGA2011-V3), Cinebench R11.5 and a variety of games. We also test the power draw of the test PC with the CPU installed. These tests reveal a broad range of performance characteristics, from image editing to gaming and video encoding to 3D rendering. We run all tests at stock speed and again when overclocked to its highest frequency.

*Please note: We test AMD FM2+ APUs using the on-board graphics, not the Nvidia GeForce GTX 780 3GB

GRAPHICS CARDS

Graphics cards are mainly evaluated on how fast they are for their price. However, we also consider the efficacy and quietness of the cooler. Every graphics card is tested in the same PC, so all results are directly comparable.



CUSTOM PC MEDIA BENCHMARKS



2.66GHz Intel Core 2
Duo E6750

+



2GB of Corsair
1,066MHz DDR2

+



250GB Samsung
SpinPoint P120S

+



Asus P5K Deluxe WiFi-AP

= 1,000

Our benchmark suite simulates how people really use PCs, and a higher score is better. You can download the suite from <http://tinyurl.com/CPCbenchies>

MOTHERBOARDS

Motherboards are evaluated on everything from layout and features to overclockability and value for money. Every motherboard is tested with the same components, so all results are directly comparable.

INTEL LGA1150



Intel Core i7-4790K Motherboard on test 16GB Corsair Vengeance Pro 1,600MHz DDR3 240GB OCZ Vector 90

INTEL LGA2011-V3



Intel Core i7-5960X Motherboard on test Plextor M6 256GB 32GB Crucial 2,133MHz DDR4

AMD FM2+



AMD A10-7850K Motherboard on test 16GB Corsair Vengeance Pro 2,133MHz DDR3

COMMON COMPONENTS



Nvidia GeForce GTX 780 3GB* Windows 7 64-bit

TESTS: We use the Custom PC Media Benchmarks (or CPC RealBench 2014 on LGA2011-V3) and several games, and also test the speeds of the board's SATA ports. We try to overclock every motherboard we review by testing for a maximum QPI, base clock or HTT as well as overclocking the CPU to its maximum air-cooled level. We run our tests at stock speed and with the CPU overclocked.

*Please note: We test AMD FM2+ motherboards using the on-board graphics, not the Nvidia GeForce GTX 780 3GB

The Awards



EXTREME ULTRA

Some products are gloriously over the top. These items of excellent overclock earn our Extreme Ultra award.



PREMIUM GRADE

Premium Grade products are utterly desirable – we'd eat nothing but beans until we could afford them.



PROFESSIONAL

Products worthy of the Professional award make you and your business appear even more awesome.



APPROVED

Approved products are those that do a great job for the money; they're the canny purchase for a great PC.



CUSTOM KIT

For those gadgets and gizmos that really impress us, or that we can't live without, there's the Custom Kit award.



TESTS: By using the fast PC detailed on the left, we can be sure that any limitations are due to the graphics card on test. We test the four games (above) at their maximum detail settings, in their highest DirectX mode, at several resolutions. High-end cards should be able to sustain playable frame rates at 2,560 x 1,440, while 1,920 x 1,080 is more important for mid-range cards; we also now test at 5,760 x 1,080 for three-screen setups, and 3,840 x 2,160 for 4K monitors. We also try to overclock every graphics card we test to assess the performance impact.

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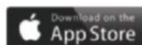
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Custom Kit

Paul Goodhead checks out the latest gadgets, gizmos and geek toys

GLOVES

hi-Fun hi-Call Bluetooth Gloves /

£25 inc VAT

Making a phone call without holding your phone already makes you look weird, as you walk down the street, apparently talking to nobody, but hi-Fun clearly wanted to take this weirdness further – behold the Bluetooth phone gloves. Yes, with a concealed speaker and microphone wired into the little finger and thumb, you can now talk on the phone by making the internationally recognised hand gesture, and holding your hand to your head.

For a novelty item, it works surprisingly well; call quality is fine and connecting is easy. The only issue is the weedy speaker, which makes it difficult to hear the caller over background noise. Oh, and the fact that you look silly when you're using it.

HIGH AND DRY ●●●●● **HIGH FIVE**

SUPPLIER www.amazon.co.uk



TOY

Ollie / **£80** inc VAT

Ollie, like Sphero before it (see Issue, 119 p54), is a motorised toy that's controlled by an app on your smartphone or tablet. Unlike Sphero, Ollie is built for speed, so rather than meandering at a sedate four miles an hour, it rips around the floor at a mildly terrifying 14 miles an hour.

However, it's obnoxiously tricky to control at top speed, and it gets beyond the range of its Bluetooth connection in five seconds too. That said, if you have the Jedi-like reflexes necessary to master the learning curve, and have £80 to spare, Ollie is undeniably fun. It's rugged enough to survive some jumps, and you get an hour of play from one charge too.

OLLIE ●●●●● **360-FLIP**

SUPPLIER www.firebox.com

USB DRIVE

SanDisk Ultra Dual USB Drive 32GB / **£15** inc VAT

We've seen a number of USB OTG (on the go) drives now and we're still impressed by their versatility. The SanDisk Ultra Dual is no different. Able to connect to both PCs and Android devices, it offers an easy way to add temporary storage to a tablet or phone – a godsend for devices without expandable memory, such as Google's Nexus range. Going on a long journey? Simply load all the movies you want to watch onto the Ultra Dual, leaving your tablet memory free for apps.

At only £15, it's affordable too, though this USB 2 drive is also slow. We measured write speeds of 9.35MB/sec, so it would take an hour to fill the drive. Happily, SanDisk has a USB 3 version coming out soon.

SEEDY ●●●●● **SPEEDY**

SUPPLIER www.amazon.co.uk





MOUSE MAT

Corsair MM200 Compact / £8 inc VAT

Over the past few years, we've seen mouse mats become bigger and wider to appease the apparent needs of gamers, so Corsair's MM200 Compact now stands out by being truly dinky. Measuring only 265 x 210mm, the Compact is comparable in size to those awful, plastic-topped mouse mats that every company seemed to give away for free in the 1990s. Thankfully, there isn't any plastic in sight on the MM200, as it's a fabric mat with a rubber underside. It provided a reliable tracking surface during testing, and while its size initially seems limiting, you get used to it quickly, especially if you're happy to increase the sensitivity of your mouse. Costing just £8, the MM200 is also eminently affordable, making it an attractive travel mat for taking to LAN events too.

WARREN TRAT ●●●●● **FIEVEL**

SUPPLIER www.ebuyer.com



POWER PACK

PNY DCM2200 PowerPack / £18 inc VAT

PNY's DCM2200 power pack for micro-USB smartphones is around the size of a lipstick, making it unobtrusive in a bag. When tested, it's 2,200mAh cell charged our Nokia phone's battery to 62 per cent of its capacity from empty – perfectly respectable for a pack of this size and price. Its built-in micro-USB connector eliminates the need to carry a cable with you, although it also makes it less flexible – you can't lend the DCM2200 to your iPhone-toting friends, for example. The connector doesn't retract into the body of the unit either, raising the concern that it could get knocked or bent, especially if it's rolling around in a bag.

BUTTERY ●●●●● **BATTERY**

SUPPLIER www.amazon.co.uk

LAPTOP ACCESSORY

Icy Box IB-DK2241AC / £84 inc VAT

While ultra-slim laptops look and feel desirable compared with their chunky desktop replacement counterparts, they're often short on connectors, thanks to their waif-like chassis, which is why Icy Box's laptop docking station has come to the rescue. Designed as a connection hub, the unit plugs into a laptop's USB 3 port and requires its own power socket. The hub then sprouts DVI, HDMI, Ethernet, 2 x USB 3, 4 x USB 2, and analogue audio in and out connections.

The station proved capable, despite only running via a USB 3 port – we output a display to an HDMI monitor, wrote to a USB stick and streamed video from iPlayer via the Ethernet port simultaneously without issue. It's also convenient to have all your connections bundled in a single, easily unplugged USB 3 device. At £84, it isn't cheap, but it does offer loads of features for the cash – you just need to be sure you'll use it before shelling out.

CRASHING ●●●●● **DOCKING**

SUPPLIER www.scan.co.uk



Seen something worthy of appearing in Custom Kit? Send your suggestions to paul_goodhead@dennis.co.uk



LABS TEST

Peripheral party

In need of a new mouse or itching to jump on the mechanical keyboard bandwagon? Our 15-peripheral roundup has you covered

In the wake of what can only be described as an eSports explosion over the past few years, more companies are fighting it out to have their peripherals become the must-have choice for gamers and hardware enthusiasts. For these companies, the marketing opportunities are too big to ignore, so there's an ever-increasing range of high-quality keyboards and mice from which we can choose.

The benefits of investing in a high-quality mechanical keyboard or a superior gaming mouse to your average three-button clicker can stay with you for years to come. Unfortunately, it's never easy to choose the peripherals that are right for you, with keyboards and

mice coming in all different shapes and sizes, not to mention sporting different switches and sensors, button configurations, lighting, sensitivity levels and so on.

As ever, that's where we come in – we've rounded up eight of the latest mechanical keyboards ranging from £72 to £117, as well as seven nifty mice from £39 to £65, and we also take a look at a premium wireless mouse. We'll be cutting through the jargon and explaining exactly what each device can and can't do, as well as how well it does it, so you'll be well on the way to choosing your ideal set of desktop companions.

MATTHEW LAMBERT AND MIKE JENNINGS

Featured this issue

How we test /p39	CM Storm Trigger-Z /p44	Logitech G402 /p53
Optical sensors vs laser sensors /p39	Corsair Gaming K65 RGB /p46	Asus ROG Gladius /p54
Mechanical gaming keyboards	Ducky DK2108SZ Zero Zone /p48	Gigabyte Aivia Krypton /p58
Corsair Vengeance K70 /p40	Roccat Ryos MK Glow /p50	Roccat Kone XTD /p60
Gigabyte Aivia Osmium /p40	Gaming mice	Zowie FK2 /p60
Qpad MK-85 /p41	CM Storm Mizar /p52	SteelSeries Sensei Wireless /p61
Asus Strix Tactic Pro /p42	Corsair Gaming Sabre Optical RGB /p52	

How we test

Objective testing of keyboards and mice isn't as easy as you might expect. While it's relatively easy to establish which graphics card runs faster than another by running some benchmarks, for example, one person's dream keyboard is likely to be another person's nightmare.

There's simply a lot of variance between peripherals when it comes to your personal preference of mechanical switch-type, whether you prefer a palm or claw mouse grip, button count, aesthetics and so on, for there to ever be one keyboard or mouse that's perfect for everyone

As such, while our reviews are based solely on ourselves using the products, we

don't award or deduct points when a product has been subjectively geared towards a specific personal preference, such as the use of one type of Cherry MX switch as opposed to another. We focus on using each product as much as possible across a wide range of applications to give us the best idea of what it can do, as well as its limitations, and we aim to make these abilities and limitations clear in our reviews.

As well as general desktop use, we use keyboards thoroughly in word processing software and put mice through their paces in image editing software too. Naturally, both peripherals are also tested in a selection of games to gauge whether there

are issues with comfort and responsiveness, particularly with mice.

We pay particular attention to how well a mouse or keyboard is built, and how easy it is to use. For example, mice and keyboards may come with all manner of extra buttons, but if they're difficult to reach or press then their usefulness is restricted.

For this reason, we also ensure that we give software (where applicable) a full workout, both to see what functionality it brings to the table and how easy it is to make use of it – buggy or confusing software will lose points, as that's something that will definitely make your everyday experience worse.

Optical vs laser

Gaming mice use sensors to keep track of precise movements, but some use optical hardware while others deploy laser sensors. These two competing technologies can both provide the speed and accuracy required for high-end gaming, but it's worth knowing how the underlying hardware works – and the pros and cons of each type of sensor.

Optical technology is older – it originally replaced archaic ball-based mice – and works by using a tiny LED in the base of the mouse. This light flashes thousands of times per second, reflecting off the surface beneath a mouse, with a CMOS sensor positioned to register those reflections – effectively taking low-resolution pictures of what's beneath the rodent. Data from the CMOS sensor is passed to a small processor inside the mouse, which analyses the minute changes in each image to tell the PC exactly what's going on.

The speed of the flashing LED can vary, which alters cursor accuracy – a faster LED will register more movements, which makes it more precise. Optical mice are often unable to match laser products for pure DPI levels, but they can be more consistent – while they don't attain high sensitivity levels, they're less susceptible to

acceleration and jittery movements. Optical mice also work on a smaller selection of surfaces, so it's best to use them on a good material – a smooth table or a gaming-grade mouse mat, for instance.

Laser mice work using a concept called Doppler Velocimetry, which shoots a beam at the surface beneath the mouse.

That beam is configured at a certain angle and frequency, and is modified when it bounces off the surface below. Another diode detects this reflected light, and the difference between the original beam and the reflected one is calculated to determine the cursor's position and movement.

Laser mice tend to work on a wider variety of surfaces than optical ones – they

Optical technology is older, and works by using a tiny LED in the base of the mouse



can cope with glass, for instance, which optical mice just can't handle. That adds versatility, and laser mice can also attain higher sensitivity levels than optical products, topping out at a mighty 8,200dpi. That's impressive, but laser devices are sometimes

not as reliable as their optical counterparts, with juddering at those extremely high DPI levels. That's worth bearing in mind, but it's a niche concern, as most gamers just don't need to run their mice at such high sensitivity levels anyway. **MJ**

Corsair Vengeance K70 / £96 inc VAT

SUPPLIER www.scan.co.uk

While Corsair's vanilla Vengeance keyboards are hard to find in the wake of the RGB update, Corsair still makes and sells them, so we're revisiting the previously Elite-listed K70. It's still a clear cut above the competition for build quality – the aluminium faceplate really seals the deal. One slight niggle, however, is the lack of rubber grip on the front or rear flip-out legs.

The raised keys are visually striking and aid when cleaning too, which is made easier with the key removal tool, which can be used to install the replacement red WASD and 1-6 keys. The keys are backed by Cherry MX Red switches, but Blue and Brown options are also offered. The K70 rewards you with a great experience when typing and gaming, and comfort is boosted by the optional wrist rest, which has a comfortable soft-touch textured surface.

In terms of features, the K70 features a single USB 2 pass-through, but there are no audio jacks, no macro key and no ability to reprogram the function of existing keys,



unlike the K65 RGB. While it's comparatively slim on features, though, the minimal design keeps the K70 compact. Its features also includes n-key rollover, and a legacy BIOS compatibility switch.

Despite the lack of key customisation, the K70 still has a number of useful features though. There's a dedicated Windows key lock, a great set of dedicated media keys and a metal audio volume wheel. The deep red backlighting also reflects attractively off the

aluminium to give the K70 a pleasant glow between its keys. There's a dedicated brightness control button as well as a pattern-record key, enabling you to set which keys are lit on a per-key basis, excluding the media keys, which stay lit.

The K70 stands the test of time very well, as it gets so many basics right – it has fantastic build quality, and it's both comfortable and always easy to use. Only a comparatively high price and lack of features lets it down. If key customisation matters to you, look elsewhere, but if not, the K70 still offers a solid and well-designed keyboard. **ML**

Gigabyte Aivia Osmium / £72 inc VAT

SUPPLIER www.awd-it.co.uk



The Aivia Osmium is a re-entry from the last keyboard Labs, where it won an Approved award. It's the least expensive model on test, but it still feels surprisingly solid. The Osmium grips your desk well though; like the Corsair K70, its front and rear legs both reduce its friction.

The thick, braided cable ends in four connectors – one USB 2 connector for the keyboard, as well as a USB 3 one and two audio jacks for the pass-through ports, which are easy to access on the right. Meanwhile, the two top-mounted scroll wheels (for brightness and volume) are easy and, while n-key rollover isn't supported, 64-key rollover is just as good in practice.

The Osmium is fully equipped with Cherry MX Red switches in our sample, or Brown switches with a white backlight. There's also a large, comfortable and

detachable wrist rest included, shaming costlier keyboards that lack one. A key removal tool and four replacement keys are supplied as well.

Five extra macro keys are found along the top, which isn't the most convenient position but keeps the keyboard's width down. Five profiles can be saved to the Osmium's memory, and changing profiles is as simple as pressing the colour-coded Aivia logo.



The tile-based Ghost software only allows you to reprogram the macro keys, but with five profiles, you have 25 onboard functions available. The software looks dated now, but it's still functional and intuitive for the most part. However, you can't set keys to launch programs of your choosing, bind profiles to applications or perform on-the-fly macro recording.

Media keys are bound to F1-F4 via the FN key, which has no other use. There's a dedicated Windows key lock too, but there's annoyingly no indication of when it's active.

The Osmium is still an excellent keyboard, particularly at its now low price. A full set of genuine Cherry MX switches with five macro keys and USB 3 support is a fantastic deal for just over £70, making it easy to recommend for anyone on a tight budget. **ML**

DESIGN	FEATURES	OVERALL SCORE
42/45	13/25	78%
VALUE		
23/30		

VERDICT

No key customisation, and quite expensive, but still a fantastic keyboard if you're chasing elegance and simplicity.

/SPECIFICATIONS

Connection Wired, USB

Cable 2m, braided

Material Plastic, aluminium

Switch type Cherry MX Red (Blue, Brown available)

Backlighting Red, per-key

USB ports 1x USB 2

Wrist rest Yes, removable

Extras N-key rollover, Windows lock, media keys, BIOS compatibility switch, key removal tool, 10 x replacement keys



Qpad MK-85 / £90 incVAT

SUPPLIER www.scan.co.uk

Like the Gigabyte, the MK-85 is a re-entry from the last keyboard Labs. It has a full set of Cherry MX keys. Our sample uses Reds, but Black, Blue and Brown are also available, although some models are more expensive. Four blank orange keys are supplied in the box too, along with a key removal tool.

With its soft-touch finish, the MK-85 is close to the CM Storm in terms of design and price. It's well built and very comfortable to use, with the Cherry switches and n-key rollover feature performing fantastically. Its desktop grip could be better though; oddly, it's actually improved with the rear legs extended.

The USB cable requires only a single connection, but the MK-85 has two USB 2 pass-through ports, as well as pass-through audio jacks. Meanwhile, media and volume control is FN-based through keys F1-F6. The keys are backlit with red LEDs, and you can alter their brightness, switch them off or set a 'breathing' effect.

The MK-85 also allows you to reprogram virtually all its keys, although there are sadly no dedicated macro keys. Settings are saved direct to the hardware too, so you can take them with you.

Unfortunately, the MK-85's feature set is more limited than that of the CM Storm. The MK-85 has five custom profiles and one default. The custom profiles are

triggered with FN-F12, which disables the Windows key. You then switch profiles with FN and F7-F11.

The software hasn't been updated past version 1 either, and it shows, being clunky and unintuitive. Macro editing can't be performed on the fly, but the editing suite is decent enough. However, overall, the software gets in the way more than necessary – it feels very outdated. It also limits you in terms of what tasks you can assign to buttons (although macros and shortcuts to any program are supported), and you can only have ten custom buttons of any sort per profile.

The MK-85 undoubtedly a good keyboard, but the similarly priced CM Storm Trigger-Z has more features thanks to its macro keys, on-the-fly recording and wider array of options, and the software is friendlier too. **ML**

DESIGN	FEATURES	OVERALL SCORE
37/45	21/25	86%
VALUE		
28/30		

VERDICT

A robust feature set, a simple and intuitive design and a very attractive price tag make the Aivia Osmium a cracking budget buy.

/SPECIFICATIONS

Connection Wired, USB

Cable 2m, braided

Material Plastic

Switch type Cherry MX Red (Brown available)

Backlighting Blue

USB ports 1x USB 3

Wrist rest Yes, removable

Extras 5 x macro keys, Windows lock, media keys, headphone/microphone jacks, key removal tool, 4 x replacement keys



DESIGN	FEATURES	OVERALL SCORE
35/45	21/25	80%
VALUE		
24/30		

VERDICT

A solid all-rounder, but it's outclassed by the similarly priced and more modern CM Storm Trigger-Z.

/SPECIFICATIONS

Connection Wired, USB

Cable 1.8m, braided

Material Plastic

Switch type Cherry MX Red (Black, Blue and Brown available)

Backlighting Red

USB ports 2x USB 2

Wrist rest Yes, removable

Extras N-key rollover, Windows lock, media keys, key removal tool, 4 x replacement keys

Asus Strix Tactic Pro / £100 inc VAT

SUPPLIER www.scan.co.uk

At £100, the Asus Strix Tactic Pro has mid-way pricing in this group test. It offers the full set of keys, plus 13 dedicated macro keys and eight more through F1-F8 when you activate its macro mode. Couple this setup with the ability to have three active profiles, which can be saved to the on-board memory, and you have a highly customisable keyboard. Of course, one downside to this design is that the Tactic Pro is very wide.

Another downside is the software. It's easy to use and navigate, but it's basic in terms of functions and it lacks polish. You're unable to remap any keys except the macro ones (which is fair enough given there are so many of them), but you can only assign macros, program launching and mouse/keyboard functions to those keys, which is limited compared with other software. Annoyingly, you also can't change the buttons to which you assign your three profiles; they're selected via the hard-to-reach Print Screen, Scroll Lock and Pause Break keys (via the FN button). That said, you can tie profiles to specific programs (such as Photoshop), so they activate when the application is launched.

Layout on the whole is good – the dedicated media keys and volume wheel are good inclusions, and they're also low-profile and non-intrusive. Some macro keys require a stretch, but that's standard fare. However, the thumb-accessible macro keys beneath the spacebar sit too far to the right, which spoils their utility in the heat of battle.

Build quality isn't as good as the Asus name and price tag would suggest either. The non-mechanical keys and volume wheel feel



very plasticky and cheap. Likewise, while the chassis is solid, it doesn't have a premium look or feel. There's no wrist rest either – a shame since many cheaper boards include one. Still, a key removal tool is supplied for easy cleaning and installing the four solid orange replacement keycaps.

Of course, the main driver of price is the Cherry MX switches. Our sample uses the linear, light, non-tactile Red variety, but Asus pleasingly offers Blue, Black and Brown alternatives too. The typing experience is of course very pleasant, and the high levels of grip, both on the base of the keyboard and the rear feet (there are no front feet) makes the keyboard feel weighty and satisfying. N-key rollover is also present, and a toggle via FN-Page Up disables this feature for compatibility with legacy applications.

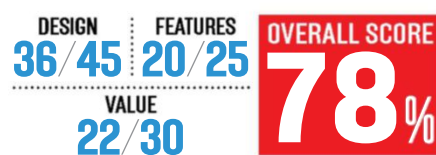
The Strix's backlighting is orange, and offers brightness control as well as the ability to turn it off or set it to a 'breathing' effect. The keyboard's indicators have a silly design, however. They're used to tell you information such as your current profile and when Caps Lock is active, for example, via a series of orange lights along the top edge with the corresponding text printed on the plastic beside them. However, you can't see this text in the dark, so you have no idea what the lights mean. It would have been much better to have the text itself backlit.

The Tactic Pro sadly offers no pass-through ports either, but a Windows Key lock function and on-the-fly macro recording are present, again via the all-powerful FN key.

Conclusion

Asus has focused heavily on key customisation with the Strix Tactic Pro. However, the software backing could use some tweaks (although setting up your macros isn't too difficult), and it's a shame the buttons, especially the thumb ones, aren't optimally positioned.

Build quality is a touch underwhelming too. As such, there are better all-rounders, but die-hard MMO or RTS fans who need lots of macro keys will still enjoy this keyboard if the orange backlighting appeals. **ML**



VERDICT

A robust feature set that's let down a little by some disappointing design choices and basic, occasionally irksome software.



SPECIFICATIONS

Connection Wired, USB

Cable 1.8m, braided

Material Plastic

Switch type Cherry MX Red (Black, Blue, Brown available)

Backlighting Orange

USB ports No

Wrist rest No

Extras 21x macro keys, n-key rollover, Windows lock, media keys, on-the-fly macro record, key removal tool, 4x replacement keys



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CM Storm Trigger-Z / £88 inc VAT

SUPPLIER www.box.co.uk

CM Storm's Trigger-Z is one of the least expensive keyboards on test, but you wouldn't know from the build quality. It's hewn from plastic, but it's a solid, weighty unit with a lovely soft-touch finish that's much more alluring than Asus keyboard's matt finish, for example, and it's also far less prone to picking up scratches and marks. Its attractively braided cable is also fully detachable for easy transportation and replacement in case of any damage.

A sensibly sized, optional wrist rest is also provided, giving you plenty of support, and the soft-touch coating is continued here for outstanding comfort. Combined with the Trigger-Z's healthy grip via its numerous rubber pads, and the use of Cherry MX switches beneath every key, it offers an excellent typing experience. It doesn't have n-key rollover, but its 64-key rollover still ensures you'll never miss a beat, and the rear legs can be used to provide a sharper angle on the desk. Currently, only the light, tactile Cherry MX Brown switches are offered though. CM Storm does produce models with Red and Blue switches but they aren't currently available in the UK.

Also included in the package is a key puller, although there are no replacement keys – it's a little off-putting having both Windows keys

fitted with FN keycaps at first, but you soon get used to it.

Meanwhile, the keys are backlit with white LEDs, and a white plate beneath them reflects light back up through the keys, which looks great. The lighting can be set to five levels of brightness, a 'breathing' effect, a gaming key pattern or disabled entirely, all via the FN key and F1-F4. Meanwhile, F5-F11 are used for media and volume controls, while F12 toggles the Windows key lock, which has a handy indicator. On the downside, though, there are no USB or audio pass-through ports.

The Trigger-Z also offers a single row of dedicated macro keys to the left of the full key set, which are easier to access in a hurry than the five on the Gigabyte. You can trigger five on-board profiles using FN and 1-5 too, and the lights flash to indicate a change.

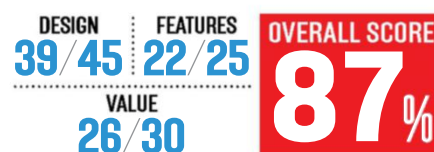
Macros can be assigned on the fly with ease, although the keyboard is 'limited' to 25 commands and 30 seconds. The downloadable software enables you to fine-tune your macros and, impressively, offers full reprogramming of almost any key (not just the macro ones), using a highly intuitive key mapping screen. All five profiles and their macros and commands are programmed and played directly from the keyboard's on-board memory, with a 75-macro limit. Keys can also be set to numerous Windows and media functions, as well as shortcuts to programs.

The macro editor is the least impressive part of the suite, as it's confusing at first and long-winded in practice, but it does allow you to record and edit delays and mouse commands. Macros can be played back in all the usual ways too, so the Trigger-Z offers a very comprehensive level of customisation.

Conclusion

By offering five dedicated macro keys, the Trigger-Z doesn't overwhelm you with keys and turn into a massive keyboard like the Asus Strix (although it's still pretty big), but it offers far more customisation than Gigabyte's Aivia Osmium, by allowing you to reprogram the standard keys too.

Importantly, the CM Storm Trigger-Z also shines outside of the realms of customisation too – it has lovely build quality, it's extremely comfortable to use, and it has other nifty and easy-to-use features too. As long as you're happy with Cherry MX Brown switches and have no need for pass-through ports, the Trigger-Z is a fantastic, good-value all-rounder and a deserving winner of this month's Labs. **ML**



VERDICT

A great balance of software-based customisation, hardware-level features and design, topped off with a very reasonable price tag.

/SPECIFICATIONS

Connection Wired, USB

Cable 1.8m, braided, removable

Material Plastic

Switch type Cherry MX Brown

Backlighting White

USB ports No

Wrist rest Yes, removable

Extras 5 x macro keys, key reprogramming, Windows lock, media keys, key removal tool



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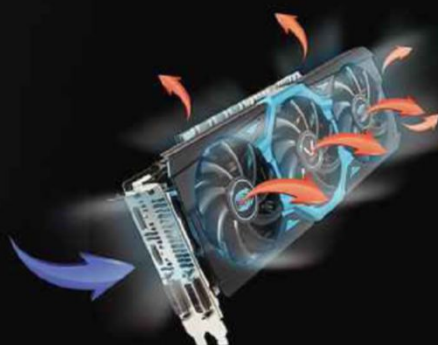
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Corsair Gaming K65 RGB / £110 inc VAT

SUPPLIER www.scan.co.uk

As the only keyboard on test without a numeric keypad, the narrow K65 RGB takes up much less desk space than this month's competitors. If you're frequently doing numerical data entry, or putting timestamps in game chats, this keyboard isn't for you though.

There are also no dedicated macro keys, but that's not to say the K65 RGB isn't a highly customisable keyboard.

It's also the only keyboard on test to feature Cherry MX RGB switches, which have a revamped design that provides enough room for an RGB LED, while still keeping the same feel of Cherry MX switches. Until the end of 2014, these switches were exclusively available to Corsair, and we're still unaware of any other company using them. Currently, the K65 is only offered in the UK with the Red switch variety.

Build quality is, like the K70, outstanding, with the aluminium faceplate providing a feel of quality that's a cut above the non-Corsair keyboards. The thick braided cable ends in dual USB plugs, but there are no pass-through ports – if you're using USB 2, the K65 RGB requires two ports, but it only needs one USB 3 port.

The K65 RGB's grip, both when flat and with the rear legs extended, is top-notch too. Coupled with the detachable, soft-touch wrist rest and the excellent typing experience of the Cherry MX RGB switches, which are indistinguishable from the regular ones, it's satisfying to use, and n-key rollover keeps the elitists happy too. The wrist rest is the only accessory supplied but, while a key puller for easy cleaning would be handy, replacement keycaps aren't essentials.

Like the K70, the K65 RGB has dedicated buttons for brightness control and locking the Windows key. However, the reduced space



sees the media keys partially moved to FN functions, with F9-F12 responsible for media playback controls. Volume is still controlled with dedicated keys, but there's no metal scroll wheel, sadly. The final hardware-based control is the BIOS compatibility switch on the back, which also toggles the USB polling rate; the K65 RGB has no on-the-fly macro recording.

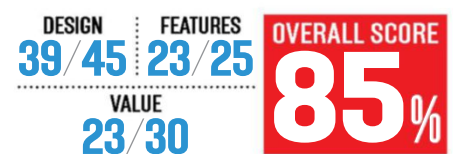
However, the K65 does offer an outstanding level of key and lighting customisation. Courtesy of the Corsair Utility Engine software, it has a hardware mode that enables you to store one profile to the on-board memory, or software mode, which allows you to set certain programs to automatically trigger various profiles. The software has a steep learning curve, which affects its usability, but it's powerful too. All keys can be remapped (including the brightness and volume controls), with the caveat being that you sacrifice a standard feature in the process. The macro editor in particular is rife with options, but keys can be set to do almost any job, including altering the mouse DPI and starting in-game timers.

The K65 RGB's backlighting options are expansive as well. You can set lighting patterns ranging from reactive single keys to waves of multiple colours spreading outwards across the board. Again, the software could definitely be more intuitive, and tuning your lighting to this degree has little effect on a keyboard's

functional qualities, but it undeniably looks fantastic.

Conclusion

If you're looking for a high-end keyboard, both the K65 RGB and the Roccat Ryos MK Glow are great choices, but they clearly target very different users. The K65 RGB is the more mature keyboard, suitable for anyone looking for a compact, elegantly designed gaming keyboard that doesn't sacrifice customisation. If that's you, and you're happy to pay the price, you won't find a better compact mechanical gaming keyboard. **ML**



VERDICT

A compact, elegantly designed gaming keyboard that doesn't sacrifice customisation. The K65 RGB is an outstanding keyboard in almost every way.

/SPECIFICATIONS

Connection	Wired, 2 x USB
Cable	2m, braided
Material	Plastic, aluminium
Switch type	Cherry MX RGB Red
Backlighting	RGB, per-key
USB ports	No
Wrist rest	Yes, removable
Extras	N-key rollover, key reprogramming, Windows lock, media keys, BIOS compatibility switch



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Ducky DK2108SZ Zero Zone / £99 inc VAT

SUPPLIER www.overclockers.co.uk

Ducky is well known for manufacturing simple but high-quality keyboards, and that's an apt description of the DK2108SZ Zero Zone, which is an entry-level model for the company. The focus is on quality over features; there are no macro keys or the ability to reprogram existing ones – you're expected to simply plug it in and start playing.

What you do get is superb build quality. The DK2108SZ is a seriously rock-solid keyboard with build quality that can't be matched by any of the plastic keyboards on test. The lack of excess plastic makes for a smart-looking keyboard in a unit that's about as narrow as possible for a full key set. When flat, the DK2108SZ has outstanding grip too, although it's let down a little by the low friction of the rear legs.

Naturally, Cherry MX switches are found behind each key, with Brown switches on our sample and Blue switches also available. The typing experience is as good as you would expect too, and the n-key rollover support is another feature we've come to expect from Ducky (FN-F12 will toggle 6-KRO for legacy applications). It's a shame the experience isn't completed by a wrist rest, although you get a key puller and a replacement set of WASD keys in the box.

Other extras are thin on the ground – there are no pass-through ports, for example. However, the DK2108SZ does include three dedicated volume control buttons and a button to launch the Windows calculator. The Windows Key can also be locked and toggled with FN-F10, with a handy indicator on the keycap itself. Likewise, the Scroll Lock, Caps Lock and Num Lock buttons have their own backlit indicators to show whether they're on or off.

Meanwhile, a feature unique to the Ducky in this Labs test is the ability to toggle the repeat delay (FN and F1-F3) and repeat rate (FN and F5-F7) via hardware. It's undoubtedly a specific and niche feature, but it's potentially useful for serial typists.

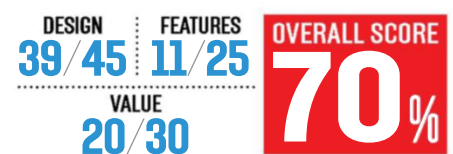
Brightness for the pleasant blue backlighting is controlled using FN and 1-7 for all the keys, and there are also options to turn it off altogether or enable a 'breathing' effect. However, if you use the FN key and numeric keypad, you can also control the lighting brightness and mode for three key zones independently. The first zone is the keys around the edge of the main alphanumeric section, the second comprises those in the middle of this section, and the third is everything else. This adds a little flexibility, but Corsair's per-key programming on the K70 is a better implementation, and it's hard to remember all the controls for the lighting without the supplied booklet to hand.

Conclusion

The Ducky name will always have a good reputation among mechanical keyboard fans. The use of Cherry MX key switches in a very solid frame with N-KRO, a few other tweaks

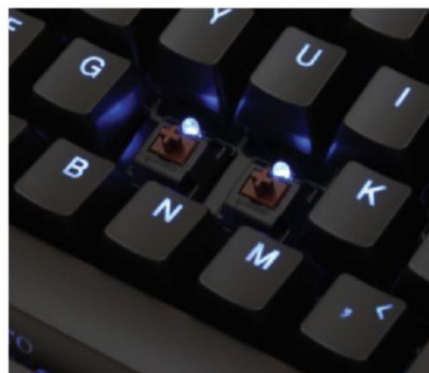
such as a Windows Key lock, backlighting and a calculator launch button make the DK2108SZ a great choice for those who want simplicity and quality – we can see it being a good tool for office use, for example (although the clicks of the Blue switch version are liable to irritate co-workers).

However, with more manufacturers now releasing mechanical keyboards now, Ducky needs to do more than the above to stand out. Corsair's similarly priced K70 is just as well built and includes a wrist rest, additional media controls and a USB pass-through port in a well-built chassis with a design that's just as simple and even easier to use. **ML**



VERDICT

Great build quality, but lacking in features. Even if simplicity and build quality are your main priorities, you'd be better served by the Corsair K70.



SPECIFICATIONS

Connection Wired, USB
Cable 2m, rubber
Material Plastic
Switch type Cherry MX Brown (Blue available)
Backlighting Blue, three zones
USB ports No
Wrist rest No
Extras N-key rollover, Windows lock, volume control, repeat delay and repeat rate toggles, compatibility toggle, key removal tool, 4 x replacement keys

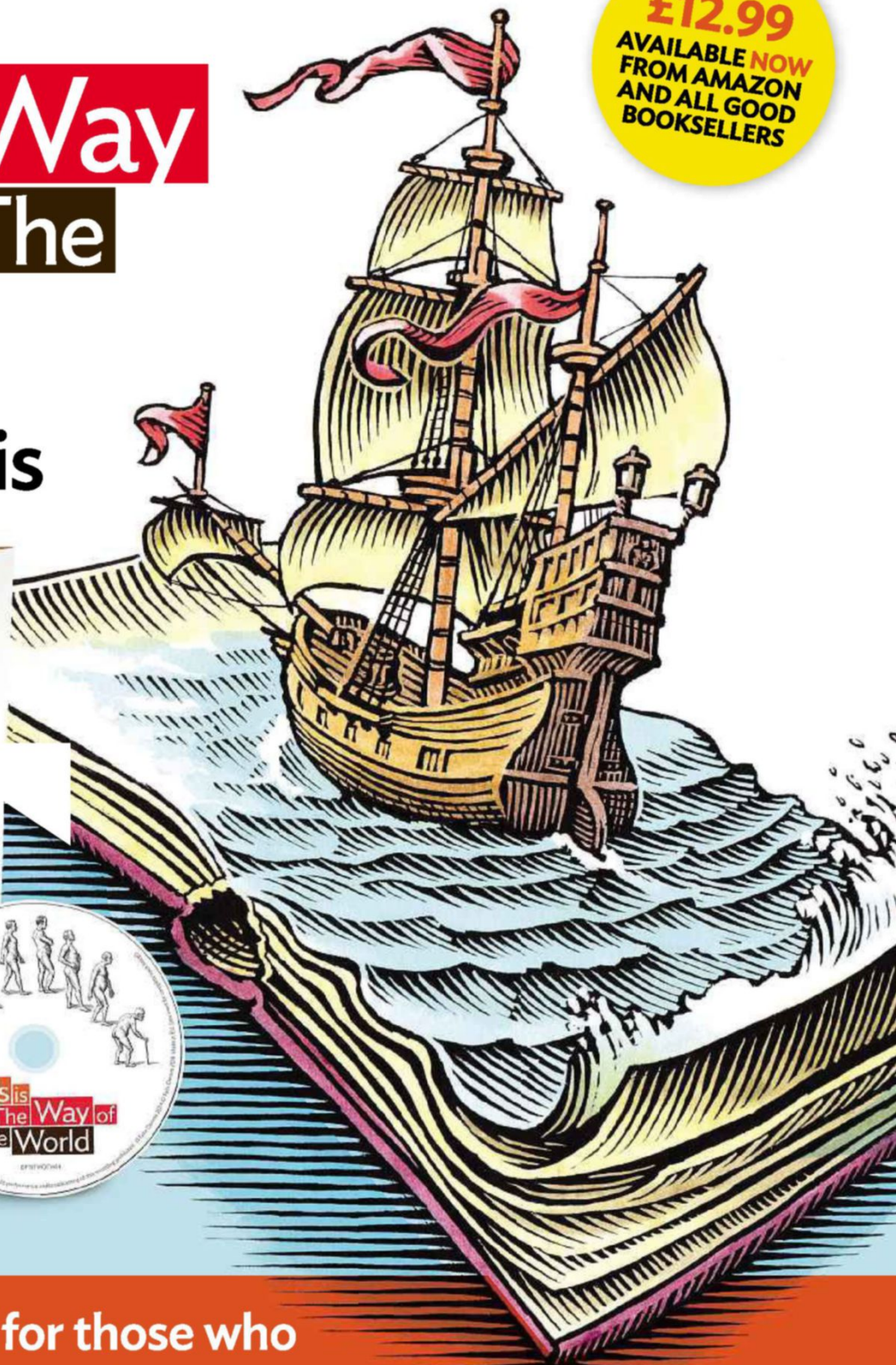
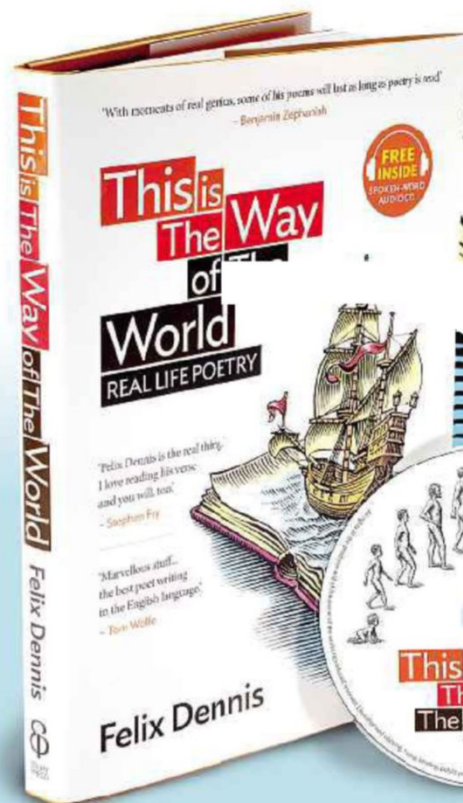
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Roccat Ryos MK Glow / £117 inc VAT



SUPPLIER www.cclonline.com

Our final product is the most expensive at £117. Like every other keyboard on test, its keys sit on top of Cherry MX switches – Browns are available as an alternative to the Blacks our sample uses, but that model is harder to find. Blacks offer the same linear, non-tactile action as Reds, but with a heavier actuation force, making them suitable for heavy-handed typists and gamers.

Of course, switch preference is highly subjective, but the quality of Cherry MX switches is undeniable, and n-key rollover is also present on the Ryos MK Glow. As such, using it is very pleasant, and the wrist rest adds to your comfort. Sadly, it doesn't have a soft-touch coating, and it's also non-removable, significantly adding to the keyboard's footprint. The Ryos MK Glow also sports rear legs and its grip is excellent with or without them extended.

Build quality elsewhere is decent, but it lacks the finesse of the Corsair, CM Storm and Ducky boards, with a plastic chassis that doesn't feel quite as strong, and the matt black and glossy surfaces will pick up marks easily. Meanwhile, blue backlighting ensures playing in the dark is no problem, with five brightness levels to choose using FN-F11.

There are no key puller or replacement keys bundled with the Ryos MK Glow, nor are there audio or USB pass-through ports.

However, all the F keys have secondary functions via the FN key, including volume and media control, as well as a quick-launch button for the Windows calculator, My Computer and browser. Windows key locking is only available through software, however.

The Roccat also has five dedicated mechanical macro keys in a column to the left, and three 'Thumbster' low-profile macro keys beneath the spacebar. All are easy to reach, with the thumb buttons in particular requiring much less stretching than on Asus' Strix Tactic. Macros can easily be recorded on the fly by pressing FN-F12 too.

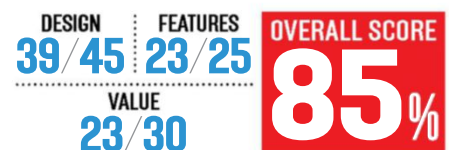
However, the Ryos MK Glow goes much further in terms of key customisation, beyond even Corsair's K65 RGB. Almost every single key is fully programmable, with both a primary and secondary function. The latter is achieved by pressing the FN key for the top row of keys, and with Roccat's EasyShift+ key for everything else, which sits in place of the Caps Lock key (although you can set it to act as a normal Caps Lock too). This fantastic feature means your customisations can be set as secondary functions, avoiding the need to sacrifice core key features. You can program keys to do practically any job, including complex macros, shortcuts of your choice, keyboard shortcuts, timers and even enable secondary functions on compatible Roccat mice.

The best part about all this customisation is that it's simple to set up, thanks to the highly intuitive and speedy software that puts many of the other software systems we've seen to shame. It's updated often, and it shows – there's even a massive list of preset macros for a wide range of popular games. You can store up to five profiles to the on-board memory too, so

you can easily take your settings with you as well. That said, it could be improved if some functions, such as Windows Key locking and profile switching were natively bound to hardware, rather than having to be first configured through software.

Conclusion

While the bulky plastic frame and Cherry MX Black switches may deter a number of users from the Roccat Ryos MK Glow, it's still an excellent, highly customisable keyboard from an objective standpoint. Like Corsair's K65 RGB, it has plenty to show for its high price, and if your top priority is tweaking your gameplay to your heart's content, this is the keyboard for you. **ML**



VERDICT

Unbeaten customisation coupled with user-friendly, gamer-orientated software and an aggressive design makes the Roccat a high-end gamer's best friend.

/SPECIFICATIONS

Connection Wired, USB

Cable 1.8m, rubber

Material Plastic

Switch type Cherry MX Black (Brown available)

Backlighting Blue

USB ports No

Wrist rest Yes

Extras 8 x macro keys, n-key rollover, media keys, on-the-fly macro record



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CM Storm Mizar / £39 inc VAT

SUPPLIER www.ebuyer.com

CM Storm's Mizar is the cheapest mouse on test, albeit by a single pound. Despite the price, though, it doesn't look out of place: the rear is decorated with a slick logo and the matt finish looks good. However, it isn't without its flaws. It's a tad small, so people with larger hands won't be able to use a palm grip without their fingertips overhanging, and the narrow middle means that players who use claw and finger grips may find their digits dangling over the edge.

Also, while the 120g Mizar is heavy, the build quality doesn't feel as solid as that of some of its rivals. The materials offer mixed comfort too – the side panels are coated with grippy rubber, but the top panels use smoother, slicker plastic.



Meanwhile, the main buttons are very responsive, but the rest aren't so impressive. The side buttons require too much force before they register clicks, and the DPI switches are flush with the surface of the mouse, which is good for avoiding accidental clicks, but it makes them trickier to hit intentionally. The scroll wheel is also positioned too low, with less surface area available than on other units.

The Mizar's eponymous software gets off to a good start. Each button is programmable, four profiles can be saved, macros can be programmed

and profiles can be made specific to different games and applications. Delve deeper, though, and limitations start to emerge. The sensitivity is adjustable between 200dpi and 8,200dpi, for example, but only in four increments – other mice are more versatile. There's no on-the-fly profile switching either, and macro setup is awkward and repetitive, with macros needing to be assigned on the main menu to profile pages. The low price also means you don't get any snazzy extras. There's no sign of a sniper button, and no adjustable weights either, although these features aren't essentials for everybody.



Corsair Gaming Sabre Optical RGB / £50 inc VAT

SUPPLIER www.dabs.com

Corsair's Gaming Sabre Optical RGB goes full on when it comes to customisation. It features four independently controlled RGB lighting zones – its logo, scroll wheel, front light and DPI indicator – and the former trio of lights can be set to any RGB colour, or set to glow with a variety of patterns.

Corsair's Utility Engine software is comprehensive too: the Actions editor serves up macros, shortcuts, timers, media controls and more. Profiles can have multiple modes, and can be chosen on the fly or assigned to particular games, and the mouse has on-board storage as well, so you can take your settings with you. Meanwhile, the Performance tab can be used to choose DPI levels and configure a sniper feature, even though the mouse doesn't have a dedicated sniper button.

The right-handed Sabre weighs a middling 100g, which might sound a little weedy for gamers who prefer a heavier rodent, but it's

deliberate – Corsair says it's evaluated each component to make it as light as possible without sacrificing performance. The Sabre is clad in soft-touch plastic that feels grippier than the slick material on the Zowie and Roccat mice, and both sides are slightly flared for thumb and finger support. We found the Sabre most comfortable when using claw and finger grips – when using a palm position our fingers were too far forward, and clicking occasionally saw the Sabre tip forward.

The optical sensor works smoothly too, with only a hint of wobble when we opted for excessively high DPI settings and every bump in our test surface was registered. The sensor is adjustable in 50dpi steps too, going all the

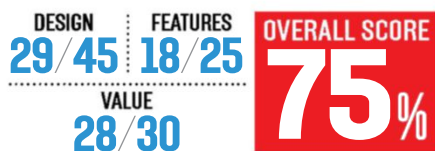
way to 6,400dpi, so every player will be able to find a setting that's right for them.

We've no complaints about the smooth and consistent Omron buttons either. The scroll wheel has pleasingly defined steps, and the thumb buttons are light. Two buttons on the left are used for DPI changes, and they have a little more resistance than the other buttons, so they're unlikely to be hit by accident.



The Mizar might have a tempting price compared with some of this month's mice, but there's a gulf in quality between this rodent and Logitech's G402. The Mizar's button quality is inconsistent, and its shape means you make a compromise no matter which grip you use, especially if you have larger hands.

The lack of features and the sluggish software don't help. Despite its attractive price tag, we recommend paying slightly more money for a better mouse instead. **MJ**

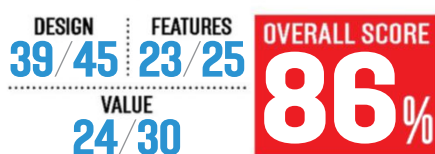


VERDICT

An attractively low price, but it's a false economy when more comfortable mice are available for not much more money.

We have few complaints about the Corsair Gaming Sabre Optical RGB's performance or build quality, and it's missing few features too – there isn't a sniper button, but that's about it. The software offers huge customisation as well, and it looks great too.

Its only problems are its price, considering the Logitech G402 costs £10 less, and it also isn't ideal for palm grip users. If you use a claw or finger grip, though, and you want a customisable, great-looking mouse, the Corsair delivers quality in spades. **MJ**



VERDICT

Well made, highly customisable and well specified, but not ideal for palm-grip fans.

Logitech G402 Hyperion Fury / £40 inc VAT

SUPPLIER www.currys.co.uk

Logitech's G402 Hyperion Fury is designed to prioritise performance over features, so it doesn't have adjustable weights, odd gimmicks or any extraneous features. What it does have, though, is Logitech's Fusion Engine.

The firm says the Fusion Engine combines an accelerometer and a gyroscope to enable the laser sensor to improve its accuracy in high-speed situations. Logitech says the Fusion Engine enables the mouse to track at 500in/sec, while the sensor alone could only manage 150in/sec.

These are impressive claims, even though few players will be able to get near that quoted 500in/sec speed.

A 32-bit ARM processor is used to process all of that information, and the G402's tracking proved flawless during our tests. The top-tier tracking is backed up with superb ergonomics too; it isn't ambidextrous, but this right-handed rodent is supremely comfortable. The long design means palm-grip users still get plenty of support, and the rubber coating offers plenty of comfort and grip. Our only qualm is minor – when using a palm grip, our ring and little fingers had no support.

Meanwhile, the buttons are located in top-notch positions and they're responsive in use. The main buttons react quickly, and the G402 is also one of the only mice on test to include a sniper button – and it's positioned perfectly beneath your thumb. DPI switching is handled by two buttons on the forward edge of the main left button, and two thumb buttons sit behind them on the left-hand edge. They default to Back and Forward commands, but they can be programmed.

The only slight fly in the ointment is the styling, although that aspect is subjective. The design intersperses matt plastic with glossy material that surrounds the scroll wheel and angles towards the back of the unit. The dull and off-centre logo also looks a tad unadventurous next to the Corsair. The G402 isn't laden with features either – we've already mentioned the lack of adjustable weights, but there's no braided cable or extra customisable lighting either.



These extras are superfluous, though, especially when the core product is so good. Logitech's G402 balances excellent ergonomics and button placement with impressive consistency, and its £40 price makes it a tad cheaper than many of its rivals too. If you want a no-nonsense gaming mouse that's brilliantly designed, and has all the parts in the right place, without paying over the odds for gimmicks, the G402 is the best you can get. **MJ**



VERDICT

A focused gaming rodent that trades extras for pure performance. It's comfortable, consistent, affordable and award-winning.

Asus ROG Gladius / £65 inc VAT

SUPPLIER www.overclockers.co.uk

Asus' Republic of Gamers range isn't known for its demure design, and that's certainly true of the Gladius mouse. The logo, DPI indicator and scroll wheel all glow red, and the sides are decorated with grippy, soft material, hewn in an angled pattern. Hands-on time reveals that the Gladius is a heavyweight rodent too. Its 116g weight makes it one of the chunkier units in the Labs, and most of that bulk is concentrated towards the rear of the mouse – it's ideal if you prefer a heavier peripheral, especially as the Gladius' weight isn't adjustable. The beefy design also impacts on build quality, which is excellent.

The shape helps too. Palm-grip users will feel comfortable, because each button is slightly concave, and those using claw and finger grips are ably supported by the textured, flared side panels. The only design decision we'd criticise is the shiny, smooth finish – it's a marked change from the soft-touch plastic used on most other mice in the Labs, and it's a little less grippy as a result.

Also unusual is the cable, which is detachable and plugs into a micro-USB connection at the front of the unit. The cable is braided and the Gladius includes a branded carry pouch, plus the box also includes a set of replacement feet.

The list of generous extras doesn't end there either. Two reliable, responsive Omron switches are installed by default, but Asus includes a pair of D2F and D2FC switches that can be installed in two sockets that sit inside the Gladius.

It's a smart, high-end inclusion that means the resistance of each button is customisable. Installation is simple: remove the feet and

some screws to open the Gladius, and slot the switches into place.

Meanwhile, the fast, comfortable main buttons are bolstered by a pair of snappy, well-located thumb buttons, and the scroll wheel is comfortable to use, although other mice have better definition between each step. A DPI-shifting button also sits behind the scroll wheel, but it's a little awkward to reach. There's no sniper button either.

Then we have the software, which is responsive and easy to use. All of the mouse's buttons and the scroll wheel's movement can be customised with macros that can also incorporate mouse clicks and delays, and Windows functions can be bound to each key too. DPI settings can be tweaked in 50dpi increments as well, and the lighting can be altered.

The sensitivity can be increased to a maximum of 6,400dpi, which should sate even the twitchiest gamers, and Asus uses an optical sensor in this mouse. It's in the



minority in a test full of laser products, but it's still perfectly fine. We certainly couldn't fault the sensor – we spotted no acceleration or unwanted jittering during testing. It helps that the software also includes a surface analyser to help you get the best performance on your specific mouse surface.

However, while the DPI and software options are extensive, the Gladius is limited in other respects. Only one profile can be stored at any time, for example, and profiles can't be automatically switched either.

Conclusion

The Gladius is a comfortable, sturdy and striking mouse, and its optical sensor proved consistent during our tests. Its customisable switches are unique in this month's Labs test too, and the carry case and detachable cable win it points for LAN party players.

Other mice better it in some areas, but if you have enough money to spend, this pricier mouse will prove a good investment if you're a serious FPS gamer. **MJ**



DESIGN	FEATURES	OVERALL SCORE
39/45	23/25	
VALUE		
23/30		85%

VERDICT

Comfortable, good-looking and equipped with cool customisable switches. It's pricey, but worth the investment if you're a keen FPS gamer.



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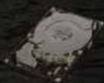
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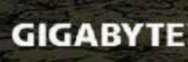
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- Full 2 Year Warranty



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- 8GB DDR3 HyperX RAM
- 120GB HyperX Fury SSD
- 1TB Seagate SSHD
- Full 2 Year Warranty



From **£999***

Gigabyte Krypton Aivia / £49 inc VAT

SUPPLIER www.scan.co.uk

There's no doubt that the Krypton is this month's most striking rodent. The Krypton logo is etched at the back of the unit in a dramatic font, and the soft-touch side panels are ridged with three angled lines designed to improve grip.

It has a selection of innovative features too. It's ambidextrous, with identical buttons on either side of the unit, and that's not all – holding down both of the mouse's forward buttons for three seconds switches between left- and right-handed modes. The base panel is also removable, and the Krypton arrives supplied with another panel that swaps its Teflon feet for convex ceramic pads designed to reduce friction, thereby gaining you a little extra speed, especially on smooth fabric surfaces.

One of the Krypton's other key features lies beneath its base panel. Ten recesses can be used to house the ten weights that are packaged with this mouse, and they can increase the weight from a middling 110g to a heavyweight 149g, which would make it the heaviest mouse in the Labs. It isn't the only mouse on test with adjustable weights, but the bevy of positions mean it's the most versatile.

While the Krypton certainly looks the part, though, it isn't quite as comfortable to hold as some other mice. The ridged lines on each side aren't as consistently grippy as the less patterned finishes on rival peripherals, and the main panels are coated with smooth plastic that isn't as grippy as the soft-touch material used on many rivals.

Its buttons are a mixed bag too. The scroll wheel is wider than any other wheel on test, but it's a little too shallow and it's comparatively difficult to click, as it requires slightly too much pressure. The same issue



affects the two sniper buttons, which require a little too much effort to press, and while the quartet of thumb buttons are easier to click, they're also too springy.

The two main buttons are snappy and responsive, but their clean bill of health is undermined by the issues elsewhere.

The DPI switch isn't great either. Instead of using one or two buttons for this job, Gigabyte has installed a small rocker that's used to adjust sensitivity up or down, to a maximum of 8,200dpi. In theory, it's a good idea, but in practice, the rocker switch just feels flimsy.

At least the Krypton has a solid shape that's suitable for all grips. It's long enough to sate palm users, and the sides are chunky enough to offer good support to claw and finger grippers. LEDs sit on either side of the rocker switch and indicate the sensitivity level selected, and they can be adjusted through nine colours. The LEDs on the sniper buttons and scroll wheel are both adjustable

too, but only the brightness can be changed on the latter.

Elsewhere, Gigabyte's Ghost Macro Engine offers reasonable customisation. Five profiles can be saved, and macros can incorporate keystrokes and delays as well as mouse clicks, which adds versatility. Sensitivity, polling rate and scrolling behaviour can be changed too, and the graphical interface used to alter these options is intuitive.

Conclusion

Gigabyte's Krypton Aivia concentrates on features and delivers a good dollop of innovation, but it does so at the expense of some fundamentals; some of the buttons aren't responsive enough, and the edgy design eschews comfort for looks. Commendably, though, the Krypton Aivia does deliver its innovative features without breaking the bank.

Even so, the Logitech G402 offers a better design for less money, meaning the Krypton is only worth considering if you crave its additional features. **MJ**



DESIGN	FEATURES	OVERALL SCORE
32/45	23/25	81%
VALUE		
26/30		

VERDICT

An innovative mouse with a loud design, but issues in fundamental areas mean you can get a better design elsewhere.

TP-LINK®

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IDEAL FOR WORK AND PLAY

FEATURES:



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Roccat Kone XTD / £50 inc VAT

SUPPLIER www.pcworld.co.uk

Roccat's Kone XTD has a sensor capable of tracking at 8,200dpi, which is an impressive statistic, but in our experience, you won't need anywhere near that resolution, whatever your play style. At least the sensor isn't the only tempting hardware. The Roccat also has a 72MHz, 32-bit ARM processor, and 576KB of internal memory that can store five profiles on the mouse. There's a genuinely handy feature called EasyShift too, which works well and grants each button an alternate action if you hold down one of the thumb buttons.

Meanwhile, the scroll wheel has good movement, and it tilts sideways, which effectively gives the XTD two extra buttons. The other buttons work well too – the main buttons are light, the thumb buttons have a little more resistance and the DPI buttons are firm enough to avoid hitting by accident.

The soft-touch surface makes holding the mouse comfortable, and the three pads on the base glide smoothly around a mouse mat. However, while the left-hand side has well-

placed thumb buttons, the right-hand edge isn't accommodating; there's no support for ring and little fingers, which are left to flounder – a disappointing design decision given the Kone's sheer bulk.

The XTD already weighs a hefty 123g, and four 5g weights can be added into a recessed section in the base.

Whether you want a heavier or lighter mouse is entirely down to personal preference, of course, and if you're after a

lighter unit, the Zowie FK2 and Logitech G402 weigh 85g and 108g respectively.

Meanwhile, the software is logically laid out. Separate tabs divide sensitivity, lighting and button options, and profile-switching options are persistent. A few options are unnecessary, though, such as the achievement system that unlocks trophies for clicks and the audio announcements for when you change DPI.

Despite the odd silly option, Roccat's software allows comprehensive



Zowie FK2 / £50 inc VAT

SUPPLIER www.overclockers.co.uk

Zowie's FK2 is the smallest mouse in this test, with a tiny frame that weighs just 85g, but that doesn't mean it's cheap. The £50 price tag puts it towards the top end of this month's group, and it also makes it £10 more expensive than the award-winning Logitech G402.

On the plus side, the lightweight design means your hand will never tire, and the FK2 is ambidextrous. It has two buttons on each side, but the FK2 isn't a seven-button mouse – you can't use the two buttons opposite your thumb. The unit is clad in matt plastic, but it isn't particularly grainy, and other mice on test offer better grip in this respect. Meanwhile, the bottom has two smooth feet (a replacement set is provided), and build quality is great too – this mouse may be light, but it's still sturdy.

Aside from the yellow scroll wheel and logo, it's a minimal design. There are no extra buttons or LEDs, and the cable isn't braided. There's also no on-the-fly sensitivity

adjustment – a switch on the base flicks between 400, 800, 1,600 and 3,200dpi – and no software is available. Similarly, the polling rate can be changed, but only when the mouse is disconnected and you press a certain combination of buttons.

However, the FK2 fought back with its superb performance. The Avago 3310 sensor worked well, with no acceleration and minimal jitter, and the low lift-off distance of 1.5mm–1.8mm is ideal for low-sensitivity players. The switches use Huano hardware, rather than more common Omron parts, and they're a little heavier. As such, rapid clicking is easier on Omron-based mice, but the Huano switches offer great levels of resistance, so it's easier to avoid accidentally triggering the buttons. Likewise, the scroll wheel is solid and moves smoothly.

Zowie says the FK2 is designed for the claw grip, but we found it worked best with a mix of claw and palm grips. Whichever we used, we found that our hefty mitts



customisation, and features such as EasyShift work well. Much of this customisation is superfluous to requirements, though, and the same goes for many of the Roccat's other features – it's already heavy enough without adding weights, and the 8,200dpi sensor is overkill too. The features are also hindered by slight ergonomic issues and the price. For £10 less, the Logitech G402 has better ergonomics and, while it might not tick all the same feature boxes, it's effectively a better gaming mouse for less money. **MJ**

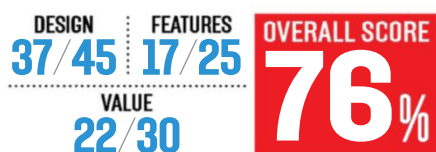


VERDICT

Distinctive, responsive and customisable, but its ergonomics are let down by the lack of support for your ring and little fingers.

overwhelmed this mouse – it's definitely ideal for those with smaller hands.

The FK2 has a decent lightweight design without superfluous extras, but its small size limits its appeal, and the lack of customisation features is a concern when you're spending £50 on a mouse. It's a well-made and well-performing rodent, but the Logitech G402 offers great ergonomics, similar performance and more features for less cash. **MJ**



VERDICT

Small and almost perfectly formed, but let down by a comparatively high price and a lack of customisation features.



WIRELESS GAMING MOUSE

SteelSeries Sensei Wireless Laser / £99 inc VAT

SUPPLIER www.currys.co.uk

The mice in this month's Labs test cost around the same price, but if you fancy spending a little more, and getting rid of the cables, the SteelSeries Sensei Wireless Laser costs a whopping £99. For that money you get the only wireless mouse in this group. The star of the show is the wireless charging pad, which is used to replenish the Sensei's battery – and also functions as its receiver, thanks to a micro-USB connection that attaches to the host PC.

It's a well-made, slick unit that adds a sheen of glamour to your desk, and we're pleased to report that the wireless connection didn't result in any noticeable lag when gaming. SteelSeries says one charge will last for 20 hours, with three hours required to fill the battery. You don't need to stop playing either – swap the micro-USB cable to the mouse, and it will still function as a wired peripheral while its power is replenished.

The mouse is ambidextrous and unfussy, with a grippy soft-touch finish bordered by a narrow, glossy edge. It's comfortable for all grip types – long enough for palm users, and wide enough to support claw and finger players.

Meanwhile, the main buttons are snappy, but not quite as light as those on other rodents. Each side is finished with comfortable soft-touch material, and

the pairs of side buttons are well-positioned. The unit weighs 120g, though, which makes it heavier than most mice in this test, and the weight isn't adjustable either.

Then there's the SteelSeries Engine application, which offers deep customisation: the Sensei's sensitivity can be ramped up to 8,200dpi and the lift distance, polling rate and acceleration can also be customised. Macros can be assigned to all of the Sensei's buttons too, and the logo can be adjusted to display one of 16.8 million colours, complete with a glowing pattern.

On the downside, the Sensei has no on-board storage, and profiles can't be switched on the fly.

There's also no way to properly analyse how much battery life is left – the wireless dock glows green if there's more than 31 per cent of the Sensei's charge left, but that's it. It's undoubtedly a luxurious product, but the flashy charging dock is backed up by solid performance: the Sensei Wireless Laser is a very comfortable peripheral to hold, we didn't notice any lag from the wireless connection and the software is reasonable. If you want a wireless gaming mouse, and you're not afraid to pay for it, this SteelSeries rodent is as good as it gets. **MJ**

Multi-GPU PCs

We ask two UK system builders to assemble PCs using multiple GPUs, to see how well they handle 4K gaming



Falcon Core 51
Pro SLI
Gaming PC

£2,000 inc VAT

SUPPLIER www.falconcomputers.co.uk



Overclockers
Ultimate Finesse
Blackhole

£1,840 inc VAT

SUPPLIER www.overclockers.co.uk

Current high-end GPUs might be incredibly fast, but they still don't have enough power to handle 4K gaming without dropping to unplayable frame rates in demanding titles. To properly enjoy 4K gaming, you need more than one card, which is why we've asked two UK PC builders to construct multi-GPU rigs for this month's head to head. Falcon and Overclockers have obliged, and it's set to be a close-run battle between the former firm's Core 51 Pro SLI and the latter's Ultimate Finesse Blackhole.

The components

Both companies have opted for Nvidia's GeForce GTX 970, with two cards in each machine. Falcon's system boasts

two overclocked Asus Strix cards, with the original 1,050MHz core and 1,178MHz boost speeds overclocked to 1,115MHz and 1,253MHz, although the 4GB of GDDR5 memory remains at 1,750MHz.

Overclockers has installed two factory-tweaked KFA2 cards, but it's also asked overclocking world champion Ian '8Pack' Parry to extract more performance from each GPU. Each one has been overclocked to 1,178MHz, with a boost peak of 1,329MHz. Elsewhere, Overclockers has modified the graphics cards by adding nickel heatpipes, new decals and components designed to reduce noise.

Both PCs rely on Intel's Core i7-5820K. It's the most modest Haswell-E part, but it's still potent, with six cores,

28 PCI-E 3 lanes, 15MB of L3 cache and a whopping 140W TDP. Both firms have overclocked the chips too, with Falcon pushing its frequency up to 4.125GHz, and Overclockers to 3.9GHz.

Both systems also deploy 16GB of DDR4 memory, with Falcon's RAM running at 2,666MHz and the Overclockers' memory clocked at 2,400MHz. Both PCs also have 250GB Samsung SSDs, but Falcon has newer hardware – its 850 Evo drive outstrips the 840 Evo inside the Overclockers PC. Overclockers takes back ground with its 2TB hard disk, though, which is twice the size of the Falcon's drive.

There isn't much to choose between the motherboards, either. The Falcon's Asus X99-A and the Overclockers' MSI X99S SLI Plus both have M.2 connectors, numerous SATA ports, and on-board power and reset buttons, and both have well-stocked I/O backplates. The Asus board has six USB 3 ports and four USB 2 connections, with eight USB 3 ports on the MSI. Both boards have five audio ports and optical S/PDIF connectors. One distinction is that the Asus has an on-board LED display, which is absent on the MSI.

Both boards are ATX-sized too, but the Overclockers rig is smaller as a whole. Its NZXT Source 340 chassis is 200mm wide and 432mm tall, so it looks tiny beside the Falcon's Thermaltake Core V51, which is 236mm wide and 540mm tall and sports a smart, meshed front panel.

The NZXT enclosure is glossy and minimal, with a slab-like front and a good-sized window. The power button and USB 3 ports sit on top of the case, and it's sturdy too – the side panels barely wobble, and 90 per cent of the case is made from steel.

The interior is designed with minimalism in mind. The power supply and hard disk bays are covered by a shroud across the bottom section, and another shroud hides cables in the middle. Hardly any cables are visible and, when they're seen, they look slick, with the graphics cards getting black, individually sleeved wires.

It's a tidy build that puts components at the forefront. The parts are further highlighted by white strip lights that illuminate the dark interior. The two modified Galax graphics cards look dark, brooding and smart, and the top half of the enclosure is dominated by the Prolimatech Genesis – a monster cooler with two stacks of heatsink fans and two 120mm fans. Airflow comes from a pair of 140mm fans at the front, and 120mm exhausts on the roof and rear. However, the solid front panel means air is only drawn into the case through small gaps at the top and bottom of the enclosure.

The NZXT looks the part, but its small size and chunky components mean the interior is cramped. The Samsung 840 Evo SSD is installed in a small metal bracket on top of the bottom shroud, but there's only one other 2.5in bay free. There's no support for optical drives either, and only room for two extra 3.5in drives.

The motherboard has 16x and 1x PCI-E slots free, and a couple of SATA ports are vacant, but all these areas are tricky to reach amid the chunky hardware and smaller case. None of this is a problem if you're not looking to upgrade, but the Falcon is more suitable if you're likely to add more components, especially storage.

The Falcon machine has a more traditional layout. Cables from the modular Thermaltake PSU delve behind the

Falcon



1

A Thermaltake Water 3.0 Ultimate cools the overclocked Core i7-5820K

2

A pair of Asus Strix GTX 970 cards in SLI handle gaming duties

3

Each drive is held in sturdy, tool-free caddies with noise-reducing washers

FALCON / SPECIFICATIONS

CPU 3.3GHz Intel Core i7-5820K overclocked to 4.125GHz

Motherboard Asus X99-A

Memory 16GB Corsair Vengeance 2,666MHz DDR4

Graphics 2 x Asus Strix GeForce GTX 970 4GB

Sound On-board

Storage 250GB Samsung 850 Evo SSD, 1TB Seagate hard disk, DVD writer

Case Thermaltake Core V51 Mesh

Cooling CPU: Thermaltake Water 3.0 Ultimate, 3 x 120mm fans; GPU: 4 x 80mm fans; front: 2 x 120mm; Rear: 1 x 120mm

PSU Thermaltake Toughpower DPS 850W

Ports Front: 2 x USB 3, 2 x audio, rear: 6 x USB 3, 4 x USB 2, 1 x PS/2, 1 x Gigabit Ethernet, 1 x optical S/PDIF, 5 x audio

Operating system Windows 8.1 64-bit

Warranty Two years parts, one month collect and return, three years labour

motherboard tray and only appear when needed, and it's generally tidy thanks to the use of cable holes with rubber grommets – our only niggle is that, at the bottom of the board, many of the smaller cables could have been arranged more neatly.

The hard disk and SSD are installed in a chunky cage towards the front, and each drive is held in sturdy, tool-free caddies with noise-reducing washers. There are five of these bays and two 5.25in bays at the top of the machine, and all of them are removable, which makes the storage setup more accommodating than the Overclockers.

Meanwhile, the CPU is chilled by a massive Thermaltake Water 3.0 Ultimate liquid cooler, and its triple-fan, 360mm radiator is installed in the case's roof, so the top half of the motherboard is kept free, so the four vacant memory slots are all accessible, although the SATA ports and two free 16x PCI-E slots are tricky to reach.



Overclockers

Photos of the Overclockers Ultimate Finesse Blackhole taken by Andy Welsh from www.overclockers.co.uk



1

The colossal Prolimatech Genesis has two stacks of fins and two 120mm fans

2

The interior is immaculate – these neatly sleeved wires are the only visible cables

3

The NZXT Source 340's shroud keeps the PSU and cables hidden away

OVERCLOCKERS / SPECIFICATIONS

CPU 3.3GHz Intel Core i7-5820K overclocked to 3.9GHz

Motherboard MSI X99S SLI Plus

Memory 16GB Team Elite Plus 2,400MHz DDR4

Graphics 2 x KFA2 GeForce GTX 970 Infinity Black Edition

Sound On-board

Storage 250GB Samsung 840 Evo SSD, 2TB Seagate hard disk

Case NZXT Source 340

Cooling CPU: Prolimatech Genesis, 2 x 120mm fans; GPU: 4 x 80mm fans; front: 2 x 140mm fans; Rear: 120mm; Roof: 1 x 120mm

PSU NZXT Super Flower Gold 750W

Ports Front: 2 x USB 3, 2 x audio, rear: 8 x USB 3, 2 x USB 2, 1 x PS/2, 1 x Gigabit Ethernet, 1 x optical S/PDIF, 5 x audio

Operating system Windows 8.1 64-bit

Warranty Two years parts collect and return, three years labour

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Performance

These machines should have the grunt to play games at 4K, and neither disappointed. In Battlefield 4 at 3,820 x 2,160, the Falcon's minimum frame rate of 33fps squeezed ahead of the Overclockers' 32fps, but the Blackhole fought back in BioShock: its 59fps minimum beat the 55fps from the Falcon. The difference between these results is minimal, though, and all are smoothly playable. In Crysis 3, however, only the Falcon's 26fps minimum was borderline playable, while the Overclockers missed our 25fps minimum target.

The two machines also traded blows in application benchmarks. We were sadly unable to get a consistent result from the Overclockers machine in our image editing

The NZXT enclosure looks glossy and minimal, with a slab-like front and a good-sized window

test, but few people are going to buy a Haswell-E machine for single-threaded performance anyway. However, the Falcon's slightly higher CPU frequency gave it the edge in our video encoding benchmark.

Conversely, the Overclockers rig was slightly ahead in our OpenCL and heavy multi-tasking tests, although not by much. In the end, the Overclockers machine scored 147,386 – behind the Falcon's result of 154,177; both results are still superb though.

We were able to eke out extra speed from both systems too. The Core i7-5820K CPUs inside these PCs topped out at 4.3GHz when we applied our overclocking skills. The overlocks improved benchmark scores, but Falcon's system remained ahead: its revised overall result of 162,818 beat the 154,741 scored by the tweaked Overclockers machine. We overclocked the graphics cards too. We increased the Falcon's core and memory clocks to 1,275MHz and 1,953MHz, and the Overclockers' speeds to 1,290MHz and 1,925MHz.

They're both decent tweaks, resulting in much more solid performance in Crysis 4 at 4K, with the Falcon PC never dropping below 30fps, and the Overclockers rig maintaining a still respectable 29fps.

These are powerful PCs, though, so it's no surprise they consumed lashings of electricity. Falcon's system was greedier, requiring 522W when running at load compared to 489W from the Overclockers machine. That situation remained when the PCs were overclocked, where the Falcon topped out at 612W. Both served up comparable noise too. When they're idle, you'll certainly notice a low rumble from both systems, and games saw the racket increase – you'll want to use good speakers or a headset when gaming, or at least put the PC under your desk.

Thankfully, neither machine gave us thermal headaches. Falcon's system started with CPU and GPU delta Ts of just over 50°C, which rose by a couple of degrees when overclocked, and the Thermalright cooler did a notably better job of cooling the CPU after overclocking it too, with a CPU delta T that was 7°C lower than the Overclockers' 62°C. Meanwhile, the Overclockers machine had a fantastic GPU delta T, never rising past 40°C, even when overclocked.

Warranty

The Falcon PC has three years of labour coverage and two years of the all-important parts protection, but only a month of collect and return service. Overclockers, meanwhile, offers a similar deal, but the whole first two years also have collect and return service, making it a better deal.

Verdict

Falcon's machine arrives with a higher overclock and a faster SSD than the Overclockers rig, which helped the

Core 51 to achieve slightly better application benchmark scores. It's a little faster in games too, achieving a borderline playable 26fps in Crysis 3, where the Overclockers rig could only manage 24fps. However, the GTX 970 cards inside both machines are overclockable, and both can maintain playable frame rates in Crysis 3 at 4K with some tweaking.

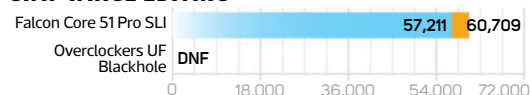
Falcon's system is slightly quicker, more expandable, sports a liquid cooler and has a quicker SSD, but it's also

more expensive, while the Overclockers machine is good-looking, better built internally, smaller and less power-hungry. Both machines are good, depending on your priorities, but our favourite is the Overclockers rig – it's neater, cheaper and still has ample grunt for applications and games, while also offering more collect and return warranty coverage than the Falcon.

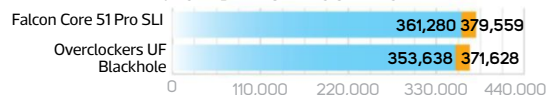
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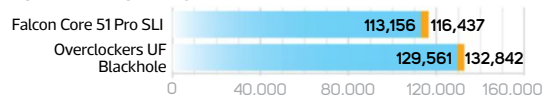
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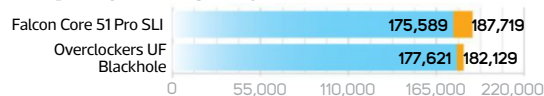
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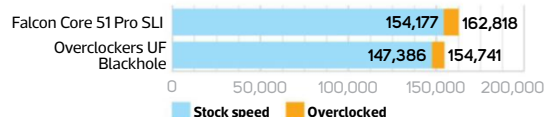
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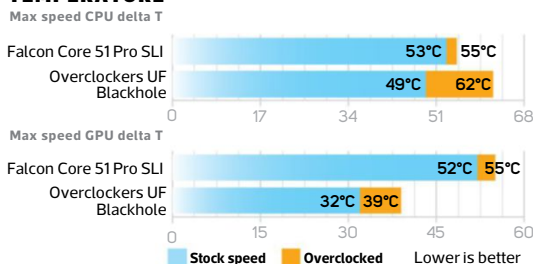
HEAVY MULTI-TASKING



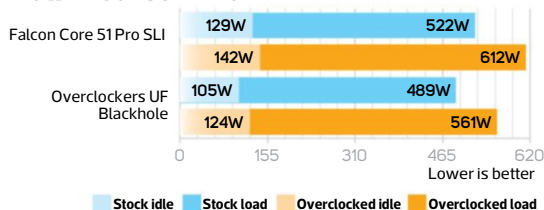
SYSTEM SCORE



TEMPERATURE

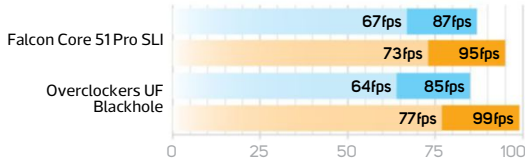


POWER CONSUMPTION

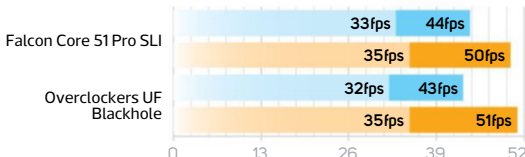


BATTLEFIELD 4

2,560 x 1,440, Ultra Detail, 4x AA

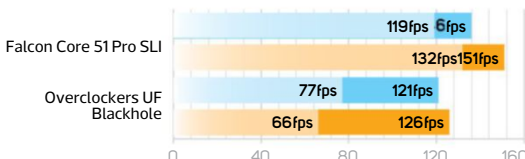


3,840 x 2,160, Ultra detail, 4x AA

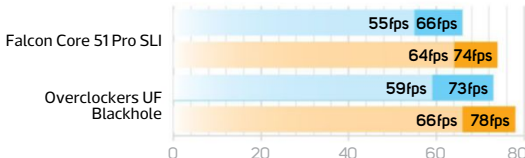


BIOSHOCK: INFINITE

2,560 x 1,440, Ultra Detail with Depth of Field

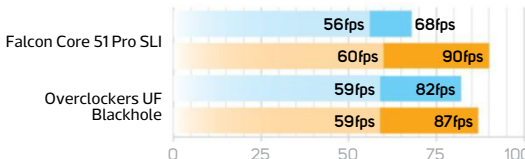


3,840 x 2,160, Ultra Detail with Depth of Field

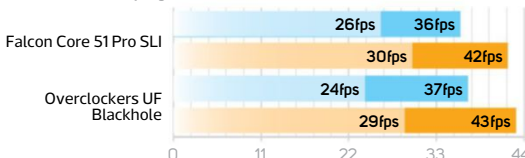


CRYSIS 3

2,560 x 1,440, Very High Detail, 0x AA



3,840 x 2,160, Very High Detail, 0x AA



FALCON

SPEED
24/25

HARDWARE
23/25

DESIGN
20/25

VALUE
20/25

OVERALL SCORE
87%

OVERCLOCKERS

SPEED
23/25

HARDWARE
23/25

DESIGN
22/25

VALUE
21/25

OVERALL SCORE
89%

Elite

Our choice of the best hardware available

Build a budget PC

Core components

The parts you'll need to build either PC. This kit list gives you a solid PSU, a decent quality case and the OEM version of Windows 7 Home Premium.



	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
1	NZXT S340	www.overclockers.co.uk	Issue 137, p54	£60
2	Corsair CS550M	www.scan.co.uk	Issue 135, p46	£64
3	500GB Seagate Barracuda ST500DM002	www.scan.co.uk	Issue 104, p72	£36
4	Lite-On IHAS124-14	www.dabs.com	Issue 99, p108	£10
5	Microsoft Windows 7 Home Premium 64-bit OEM	www.ebuyer.com	Issue 75, p46	£70

All-purpose PC

The parts you'll need to add to the core components to build a general-purpose PC. This machine will handle general computing tasks with no trouble, and will also cope with basic gaming, although you'll have to lower the detail settings. It features high-speed memory to boost the performance of the AMD APU's graphics system.

	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	Gigabyte GA-F2A88XM-D3H	www.cclonline.com	Issue 126, p22	£54
	AMD A10-7850K	www.scan.co.uk	Issue 127, p17	£116
	8GB Corsair Vengeance Pro Series 2,400MHz DDR3	www.scan.co.uk	Issue 132, p22	£73
	SilverStone Argon AR01	www.scan.co.uk	Issue 132, p57	£26
TOTAL				£509

Gaming PC

The parts you'll need to build a budget machine capable of playing the latest games at maximum settings on a 1080p monitor. The machine has a discrete graphics card, a highly overclockable dual-core CPU and high-speed memory. Meanwhile, the Z97 motherboard gives you headroom to upgrade to a faster CPU later.

	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	ASRock Z97 Pro3	www.overclockers.co.uk	Issue 130, p50	£78
	Intel Pentium G3258	www.scan.co.uk	Issue 132, p17	£54
	AMD R9 270X 2GB	www.overclockers.co.uk	Issue 126, p50	£130
	Corsair Vengeance Pro Series 2,400MHz DDR3	www.scan.co.uk	Issue 132, p22	£73
	SilverStone Argon AR01	www.scan.co.uk	Issue 132, p57	£26
TOTAL				£601

Recommended extra

A solid state drive will make a huge difference to the responsiveness of Windows, as well as boot-up times. We strongly recommend adding one to any build.











	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	Samsung SSD 840 Evo 250GB	www.cclonline.com	Issue 128, p52	£93



Build a mid-range PC

Work PC

The parts you'll need to build a solid quad-core PC with plenty of upgrade potential. This kit list gives you an all-in-one liquid cooler and a K-series Core i5 CPU, meaning you can overclock it and get some serious processing power. We've managed to get the Core i5-4690K Haswell CPU up to 4.8GHz, so it has some serious performance potential. Also included is a solid Corsair PSU, a 512GB SSD and 8GB of high-speed memory. The core configuration assumes you won't be doing any serious gaming, however, and it relies on Intel's integrated graphics.

	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	NZXT Phantom 530	www.overclockers.co.uk	Issue 127, p44	£98
	Gigabyte Z97X-SLI	www.overclockers.co.uk	Issue 130, p54	£90
	Intel Core i5-4690K	www.overclockers.co.uk	Issue 132, p18	£186
	Corsair Vengeance Pro Series 2,400MHz DDR3	www.scan.co.uk	Issue 132, p22	£73
	NZXT Kraken X41	www.overclockers.co.uk	Issue 138, p57	£80
	Corsair CS550M	www.scan.co.uk	Issue 135, p46	£64
	Seagate Barracuda 2TB ST2000DM001	www.scan.co.uk	Issue 104, p75	£60
	Lite-On IHAS124-14	www.dabs.com	Issue 99, p108	£10
	Crucial MX100 512GB	www.cclonline.com	Issue 131, p17	£155
	Microsoft Windows 7 Home Premium 64-bit OEM	www.ebuyer.com	Issue 75, p46	£70
			TOTAL	£877

Gaming PC











The graphics card you'll need to play current games at their maximum settings at 1080p and 2,560 x 1,440.

	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	1,920 x 1,080 AMD R9 270X 2GB	www.overclockers.co.uk	Issue 126, p50	£130
	2,560 x 1,440 MSI GeForce GTX 970 Gaming 4G	www.ebuyer.com	Issue 135, p20	£290

Build a performance PC

Work PC

The parts you'll need to build a high-quality, fast PC that's ideal for multi-threaded workloads. This kit list features a high-quality, beautifully built case, and has a Core i7-4790K CPU. This processor's support for Hyper-Threading effectively splits the resources of the CPU's four physical cores into a further four virtual cores, meaning it can effectively handle eight threads at once. There's also a solid 850W PSU, giving you plenty of headroom for overclocking and adding multiple graphics cards, and a Corsair H80i all-in-one liquid cooler.

	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	SilverStone Fortress FT05 UPDATED	www.scan.co.uk	Issue 139, p24	£130
	Asus Maximus VII Ranger	www.scan.co.uk	Issue 131, p20	£133
	Intel Core i7-4790K	www.overclockers.co.uk	Issue 132, p19	£260
	Corsair Vengeance Pro Series 2,400MHz DDR3	www.scan.co.uk	Issue 132, p22	£73
	Corsair H80i	www.scan.co.uk	Issue 116, p64	£74
	SilverStone Strider Gold 850W	www.scan.co.uk	Issue 135, p56	£109
	Seagate Barracuda 2TB ST2000DM001	www.scan.co.uk	Issue 104, p75	£60
	Lite-On IHAS124-14	www.dabs.com	Issue 99, p108	£10
	Samsung SSD 850 Evo 500GB	www.dabs.com	Issue 138, p26	£194
	Microsoft Windows 7 Home Premium 64-bit OEM	www.ebuyer.com	Issue 75, p46	£70
			TOTAL	£1,113

Gaming PC

The graphics card you'll need to play current games at their maximum settings at 2,560 x 1,440 and beyond.

	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	2,560 x 1,440 MSI GeForce GTX 970 Gaming 4G	www.ebuyer.com	Issue 135, p20	£290
	4K 2 x AMD Radeon R9 290 4GB	www.scan.co.uk	Issue 135, p92	£460

*Note: Multiple graphics cards are required to run Crysis 3 smoothly at 5,760 x 1,080 and 3,840 x 2,160, and Battlefield 4 at 5,760 x 1,080.

Recommended extra

A discrete sound card gives you higher-quality sound when playing back or recording music.












	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	Creative Sound Blaster Z	www.overclockers.co.uk	Issue 116, p42	£60



Build a 6-core workstation

Multi-threaded workstation

The parts you'll need to build a PC with serious power in multi-threaded workstation software, such as 3D rendering apps and optimised distributed computing software. The kit list features a 6-core LGA2011-v3 CPU, which is overclockable using the motherboard and cooler listed. Also supplied is 16GB of RAM, 1TB of solid state storage and a 1.2kW PSU, providing loads of headroom for adding multiple GPUs.

	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	Corsair Obsidian 750D	www.scan.co.uk	Issue 123, p30	£131
	Asus X99 Deluxe	www.overclockers.co.uk	Issue 136, p20	£300
	Intel Core i7-5820K	www.overclockers.co.uk	Issue 134, p43	£308
	AMD R9 270X 2GB	www.overclockers.co.uk	Issue 126, p50	£130
	16GB Corsair Vengeance LPX 2,666MHz DDR4	www.scan.co.uk	Issue 136, p14	£231
	Corsair Hydro Series H105	www.scan.co.uk	Issue 138, p48	£87
	Corsair Professional Series AX1200i	www.scan.co.uk	Issue 111, p40	£239
	Samsung SSD 850 Evo 1TB	www.dabs.com	Issue 138, p26	£360
	Seagate Barracuda 2TB ST2000DM0001	www.scan.co.uk	Issue 104, p75	£60
	Lite-On IHAS124-14	www.dabs.com	Issue 99, p108	£10
	Microsoft Windows 7 Professional OEM (or Windows 8.1 if you're using a 4K monitor)	www.ebuyer.com	Issue 75, p46	£109
			TOTAL	£1,965

4K gaming PC










This LGA2011-v3 system can support multiple graphics cards over 28 PCI-E 3 lanes, making it an ideal foundation for high-resolution PC gaming, replacing the graphics card listed above with two high-spec cards. We recommend using Windows 8.1, rather than Windows 7, if you're using a 4K monitor.

	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	4K 2 x AMD Radeon R9 290 4GB	www.scan.co.uk	Issue 135, p92	£460
			TOTAL	£2,295

Build a mini PC

Core components

The parts you'll need to build either PC. This kit list gives you a solid PSU, 8GB of RAM, an overclockable Haswell CPU, an all-in-one liquid cooler and Windows 7 Home Premium. Also included is a graphics card that can play current games at their maximum settings at 2,560 x 1,440, and a 512GB SSD.

	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	Intel Core i5-4690K	www.overclockers.co.uk	Issue 132, p18	£186
	Corsair Vengeance Pro Series 2,400MHz DDR3	www.scan.co.uk	Issue 132, p22	£73
	Corsair H75	www.overclockers.co.uk	Issue 138, p46	£59
	Asus GeForce GTX 970 DirectCU Mini UPDATED	www.overclockers.co.uk	Issue 139, p20	£282
	Crucial MX100 512GB	www.cclonline.com	Issue 131, p17	£155
	Seagate Barracuda 2TB ST2000DM001	www.scan.co.uk	Issue 104, p75	£60
	Lite-On IHAS124-14	www.dabs.com	Issue 99, p108	£10
	Corsair CS550M	www.scan.co.uk	Issue 135, p46	£64
	Microsoft Windows 7 Home Premium 64-bit OEM	www.ebuyer.com	Issue 75, p46	£70



Mini-ITX PC

The parts you'll need to build a pint-sized powerhouse.

	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	Corsair Obsidian 250D	www.dabs.com	Issue 136, p41	£65
	Asus Maximus VII Impact	www.dabs.com	Issue 136, p52	£171
			TOTAL	£1,195










Micro-ATX PC

The parts you'll need to build a mini PC that doesn't take up as much room as a full-sized desktop.





	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	Fractal Design Arc Mini R2	www.cclonline.com	Issue 127, p46	£71
	Asus Maximus VII Gene	www.dabs.com	Issue 133, p18	£151
			TOTAL	£1,181



Cases

	TYPE	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	Budget ATX	NZXT S340	www.overclockers.co.uk	Issue 137, p54	£60
	Sub-£100 ATX quiet	Fractal Design Define R5	www.scan.co.uk	Issue 137, p20	£87
	Sub-£100 ATX performance	NZXT Phantom 530	www.overclockers.co.uk	Issue 127, p44	£98
	Sub-£150 ATX	SilverStone Fortress FT05 UPDATED	www.scan.co.uk	Issue 139, p24	£130
	Water-cooling ATX	SilverStone Temjin TJ07B-W	www.overclockers.co.uk	Issue 63, p87	£220
	Mini-ITX tower	Corsair Obsidian 250D	www.dabs.com	Issue 136, p41	£65
	Mini-ITX cube	Antec ISK600	www.overclockers.co.uk	Issue 126, p28	£50
	Micro-ATX	Fractal Design Arc Mini R2	www.cclonline.com	Issue 127, p46	£71
	Water-cooling micro-ATX	Parvum Systems S2.0	www.overclockers.co.uk	Issue 129, p22	£140


Graphics cards

	TYPE	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	1,920 x 1,080 gaming	AMD Radeon R9 270X 2GB	www.overclockers.co.uk	Issue 126, p50	£130
	2,560 x 1,440 gaming	MSI GeForce GTX 970 Gaming 4G	www.ebuyer.com	Issue 135, p20	£290
	High-end single-GPU gaming	Nvidia GeForce GTX 980	www.scan.co.uk	Issue 135, p18	£420
	4K gaming	2 x AMD Radeon R9 290 4GB	www.scan.co.uk	Issue 135, p92	£460
	Mini-ITX	Asus GeForce GTX 970 DirectCU Mini UPDATED	www.overclockers.co.uk	Issue 139, p20	£282






Power supplies

	TYPE	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	Mid-range 550W	Corsair CS550M	www.scan.co.uk	Issue 135, p46	£64
	High-end 750W	Corsair HX750i	www.dabs.com	Issue 135, p52	£117
	Mid-range 850W	SilverStone Strider Gold 850W	www.scan.co.uk	Issue 135, p56	£109
	High-end 1.2kW	Corsair Professional Series AX1200i	www.scan.co.uk	Issue 111, p40	£239





Networking

	TYPE	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	Router	Asus RT-AC68U	www.dabs.com	Issue 128, p88	£160
	Wi-Fi adaptor	Asus PCE-AC68	www.ebuyer.com	Issue 128, p88	£62





Storage

	TYPE	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	Hard disk	Seagate Barracuda 2TB ST2000DM001	www.scan.co.uk	Issue 104, p75	£60
	250GB SSD	Samsung SSD 840 EVO 250GB	www.cclonline.com	Issue 128, p52	£93
	512GB SSD	Crucial MX100 512GB	www.cclonline.com	Issue 131, p17	£155
	1TB SSD	Samsung SSD 850 Evo 1TB	www.dabs.com	Issue 138, p26	£360
	NAS box	Synology DS215J	www.cclonline.com	Issue 138, p17	£144



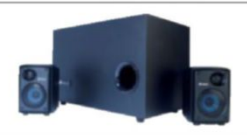

Monitors

	TYPE	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	24in monitor	Dell U2414H	www.overclockers.co.uk	Issue 129, p43	£200
	27in monitor (2,560 x 1,440)	ViewSonic VP2772	www.cclonline.com	Issue 129, p60	£582
	29in monitor	Asus PB298Q	www.scan.co.uk	Issue 129, p52	£347
	28in 4K monitor	Asus PB287Q	www.scan.co.uk	Issue 133, p44	£450





Peripherals

	TYPE	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	Budget mechanical keyboard	Gigabyte Aivia Osmium UPDATED	www.awd-it.co.uk	Issue 139, p40	£72
	Mechanical gaming keyboard	CM Storm Trigger-Z UPDATED	www.box.co.uk	Issue 139, p44	£88
	Mechanical MMO keyboard	Corsair Vengeance K95	www.cclonline.com	Issue 123, p64	£133
	Gaming mouse	Logitech G402 Hyperion Fury	www.currys.co.uk	Issue 139, p53	£40
	Wireless gaming mouse	SteelSeries Sensei Wireless	www.currys.co.uk	Issue 139, p61	£99
	Flight stick	Saitek X-55 Rhino H.O.T.A.S.	www.overclockers.co.uk	Issue 131, p29	£180
	Steering wheel and pedals	Thrustmaster TX Ferrari 458 Italia Edition	www.lambda-tek.com	Issue 137, p32	£240

Audio

	TYPE	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	PCI-E sound card	Creative Sound Blaster Z	www.overclockers.co.uk	Issue 116, p42	£60
	USB sound card	Asus Xonar Essence One	www.overclockers.co.uk	Issue 118, p44	£363
	2.1 speakers	Corsair SP2500	www.scan.co.uk	Issue 118, p75	£170
	Headset	HyperX Cloud	www.overclockers.co.uk	Issue 130, p32	£65

Systems

	TYPE	NAME	SUPPLIER	FEATURED	PRICE (inc VAT)
	Budget gaming PC	Scan 3XS Z97 Performance GT	www.scan.co.uk	Issue 133, p60	£599
	Quiet gaming PC	Chillblast Fusion Serenity	www.chillblast.co.uk	Issue 138, p66	£1,499
	Dream PC	Scan 3XS Bear	www.scan.co.uk	Issue 125, p58	£6,999
	Devil's Canyon gaming PC	Scan 3XS Z97 Performance GTX	www.scan.co.uk	Issue 136, p60	£1,199
	4K gaming PC	Overclockers UK Infinity Vesuvius	www.overclockers.co.uk	Issue 131, p62	£4,108
	Micro-ATX gaming PC	AWD-IT Chimera i5 Dead Silence Gaming PC	www.awd-it.co.uk	Issue 135, p64	£949
	Gaming laptop	MSI GT70 2PC Dominator	www.overclockers.co.uk	Issue 129, p26	£1,320
	Haswell-E PC	Scan 3XS X99 Cyclone SLI	www.scan.co.uk	Issue 134, p60	£3,349

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3. Microsoft Surface Pro 3

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- Windows 8.1 Pro.



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4. Lenovo ThinkCentre Edge 73 Mini Tower PC

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6. Microsoft Wired Desktop 400 for Business

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Games



Featured this month

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The Old City: Leviathan p82 / Neo Scavenger p84 / The Engine Room: Alien Isolation p86



RICK LANE / INVERSE LOOK

THE GAME INDUSTRY DIET

After gorging on massive games at the end of 2014, Rick Lane outlines a new diet to help the game industry trim the fat

The last few months of 2014 were a feasting frenzy for me. I'm not referring to gobbling Christmas turkey or downing drinks at New Year. I'm talking about the ceaseless banquet of enormous games that have become an inevitability at the end of a year. November and December alone saw the release of *Assassin's Creed: Unity*, *Far Cry 4*, *Elite Dangerous*, *The Crew* and *Dragon Age: Inquisition*, all of which demand between 30-60 hours of your time to get the most out of them.

Of course, it's possible to be big without being fat, and similarly, it's possible for a game to be large without wasting your time. However, all the above games (even the great ones) carried a bulge under their respective shirts that certainly wasn't muscle. Just like ourselves after the festive period, it's past time that the game industry got off its backside and went for a run, so I've been sketching out a diet and exercise plan to tackle the gaming obesity crisis.

The first step to a healthier virtual lifestyle is to stop snacking on unnecessary calories. In gaming terms, these calories come in the form of collectibles. I discussed this topic last month, but it's worth reiterating that all those tiny, utterly arbitrary distractions add up to a serious waste of the player's increasingly valuable time. If you're going to tempt the player into doing a task, ensure that it has some intrinsic value.

Another key factor in a good gaming diet is portion size, especially when it comes to missions or quests. If a quest involves fetching an object, ensure it's an interesting object, rather than three uninteresting objects. Similarly, don't insult

If your game is story focused, then every aspect of it should feed into the narrative

the player by padding out your game with template-based activities unless they lead to more variety. In an RPG that's already sprawling like *Dragon Age: Inquisition*, there's simply no need for cookie-cutter missions or MMO-style fetch quests.

All of which leads us to the next lesson for ensuring your game is healthy. Build your dish around the meat, and don't throw unnecessary ingredients into the mix. If your game is story focused, then every aspect of it should feed into the narrative. If the story isn't important to your game, don't string along the player, pretending the story is significant. Instead, focus on their experience, and use your systems to make that experience the story. Games such as *Spelunky*, *Rogue Legacy* and *DayZ* can be as long or short as you want.

The final and most important note in the developer's diet plan is to always keep the player active. If your game has cutscenes, try to make them interactive, and *never* include a cutscene in which the characters perform an action that would be cool to experience in play.

Similarly, if the game involves a lot of travelling, ensure that travelling is enjoyable, either through engaging movement systems, or by allowing chance encounters to occur on the road (though not too many if the game is story focused). If neither of these options is viable for some reason then a fast-travel ability is a necessary, albeit not ideal, substitute.

Either way, the player should never be passive, and never wait for the game to do something. If developers and publishers keep the above tips in mind, gaming will be a healthier and more enjoyable hobby for everyone. **SPG**

Rick Lane is Custom PC's games editor. [@Rick_Lane](#)

Saints Row: Gat out of Hell / £14.99 inc VAT

DEVELOPER Volition / PUBLISHER Deep Silver / WEBSITE www.deepsilver.com

Despite starting as a mediocre GTA clone, Saints Row has become an enjoyable open-world game series. The third game deliberately parodied its previous design, emphasising comedy by transforming its crew of criminal miscreants into oddly endearing celebrities who fought quirkily themed gangs of hackers and Luchadores. The fourth game was even better – a delightfully silly and inclusive adventure that combined alien invasions, matrix-like virtual worlds and liberating superpowers. Volition then needed something new for the next game, but Gat out of Hell isn't that game.

Instead, it's an expansion pack for Saints Row IV. It's a well-made expansion pack for the most part, but it can no longer overcome the problems that have grown more evident in the series over time. To briefly summarise, the character you played in all previous Saints Row games, known as the Boss, is kidnapped by Satan, who wants a sufficiently devilish husband for his daughter Jezebel.

Accompanied by super-hacker Kinzie Kensington, lovable mass murderer Johnny Gat dives through a portal, arriving in a vision of Hell that Kinzie describes as looking 'a lot like Steelport'. Given the power of flight after obtaining Lucifer's lost Halo, and aided by Hell's disgruntled

district leaders, including Blackbeard, Vlad the Impaler, and ... er ... Shakespeare, Johnny sets about causing as much mayhem in the underworld as possible, gradually piecing together his plan to shoot Satan in the face.

As expansion packs go, Gat out of Hell is both exceedingly generous and frustratingly limited. While it's smaller than the cities seen in other Saints Row games, Hell still impresses in terms of its size, while each of its five districts, such as the rocky Barrens or the neon-drenched Entertainment District, has a distinct flavour. Yet the grey and orange colour palette does nothing to complement the aging

engine, and some areas are better designed than others. The starting district, for example, looks like a bland grey smudge.

Volition's strongest asset, its sense of humour, is on display too. Again, though, its tugging at an invisible leash. The script and cutscenes are brimming with wit and charm, going so far as including a musical number that would pass on any West End stage. Unfortunately, there are only about three or four notable character interactions in the entire game, with most of the story being told through simplistic storybook narration.

Similarly, your initial encounters with the district leaders are superb. Vlad the Impaler is incarcerated in



a nursery-like prison that plays 'Wheels on the Bus' in an endless loop, while Shakespeare is the head of a local rave club and speaks entirely in monologue. But these characters exist only to dispense new powers and missions, after which they play no further role in the story.

Speaking of missions, another telltale sign of the restraints within which Volition was working is the distinct lack of a central campaign. Instead, completing side activities and causing general mischief slowly fills a bar representing Satan's wrath, which triggers story events when it reaches a certain level. In many open-world games this system wouldn't be an issue, but ironically, Saints Row is one of the few examples where the central campaign was genuinely worth playing.

Luckily, the side missions are mostly enjoyable, although some such as 'Torment Fraud', in which you throw tortured souls into traffic in order to speed up their punishment sentences, are rehashed from Saints

Row IV. New activities include capturing soul 'extraction' facilities and 'marshalling grounds' for teleportation, as well as Hellblazing, where you race through checkpoints across the city using your angelic wings.

Ah yes, the wings. Saints Row IV revolutionised open-world travel with its wonderful gliding and super-sprinting abilities, and that idea is further evolved in Gat out of Hell. Flying around the environment is so thrilling and graceful that you'll only use the cars and bikes out of curiosity. Vitally,



OVERALL SCORE

65%

/ VERDICT

Gat out of Hell delivers more anarchic Saints Row shenanigans, but it doesn't quite fulfil its obvious potential.

The script and cutscenes are brimming with wit and charm



Volition avoids making the flight mechanics too simplistic. Descents increase your speed, while ascent decreases it, so to maintain momentum, you must make precise use of extremely limited wing-flaps, which provide a short burst of speed. Later on you need to master evasive manoeuvres as Satan deploys anti air missiles. That's a sentence you won't see anywhere outside of a Saints Row review.

Other powers, such as the earthquake-inducing stomp, return in slightly altered forms, alongside a new Summon ability that lets you conjure swarms of Imps and eventually hulking demons. The new arsenal of hell-themed guns is inventive but a little underwhelming, with the exception of the stake-firing shotgun, which is so conceptually ingenious and devastatingly effective it was pretty much the only gun we ever used. Like every other aspect of the game, though, your powers and equipment are a mixture of the brilliantly inventive and the slightly disappointing.

Moment to moment Gat out of Hell is pure fun, as you swoop to a location, perform whatever activity demands your attention, laugh at Johnny Gat's offhand gags, and then blast off to find the next distraction. It never wants to be anything other than entertaining, and it drip-feeds this entertainment to you in five-minute increments of condensed fun.



At the same time, it's impossible to ignore the fact that Gat out of Hell could be considerably better if Volition was given the time and budget to make it so. You can see the potential pressing against the confines of the game, like a butterfly stuck inside its chrysalis. The lone musical number is a prime example, hinting at the far better game that Volition is more than capable of creating.

As it stands, Saints Row: Gat out of Hell is a perfectly adequate expansion pack, bringing a new location to explore, new activities and (a few) new jokes. But the idea is worthy of a sequel, and Volition is worthy of the budget to make it.

RICK LANE

Resident Evil HD Remaster / £15.99 inc VAT

DEVELOPER Capcom / PUBLISHER Capcom / WEBSITE www.capcom.co.jp/biohd

This remastered version of Resident Evil is based on the 2002 GameCube version of the classic survival horror, which itself provided a visual update from the 1996 original. On the PC, though, Capcom's loving overhaul marks the game's first visual upgrade in almost 20 years, and it's virtually as fresh and scary as the original game two decades ago.

Capcom has added widescreen support, resolution upgrades, graphical filters, remastered audio and a new control system. Many of these improvements are crucial when optimising the game for modern machines, but they still mostly build on Capcom's fabulous work 15 years ago, bringing the sumptuous pre-rendered backgrounds and foreboding atmosphere of the GameCube version to life. As Jill Valentine and Chris Redfield dash into the mansion's lavish main hall during the opening segment, it's difficult to believe the game didn't look this good 20 years ago.



The remaster isn't perfect. Some of the less significant areas of the mansion, such as the Eastern corridor, are a little chunky in the pixel department, and the character models look more action-figure than human (although updated character models are available for Jill and Chris). In addition, the gloomy, desaturated styling is a touch overdone, belying the fact that the original game was fairly colourful. Also, while the new control scheme works fine with a gamepad, moving along corridors involves a moderate amount of zigzagging when you're using a keyboard and mouse.

The Resident Evil remaster has arrived at an opportune moment for tough, uncompromising games, though, and many of the design decisions seem deeply refreshing after years of games that hold your hand. Resident Evil encourages careful, considered exploration of its environments, and the static, slow-panning cameras and exquisitely rendered backgrounds lend the game a sense of class. Combat remains a rather awkward exercise in

OVERALL SCORE

85%

/ VERDICT

Despite a few ragged edges, this new HD remaster expertly reinvigorates the definitive survival horror game.

The Old City: Leviathan / £10.99 inc VAT

DEVELOPER PostMod Softworks / PUBLISHER PostMod Softworks / WEBSITE <http://postmodsoftworks.com>

The Old City: Leviathan isn't so much a walking simulator as a first-person philosophy lecture. It clearly emerged from a mind with more ideas than an inventors' convention, and demonstrates remarkable talent for level design and visual artistry. Unfortunately, the way it's implemented results in a game that's less than the sum of its parts.

Leviathan is another post-apocalypse game, but focusing on gradual decay rather than abrupt zombie spewing. A mysterious contaminant in the water supply has caused humanity to fracture into three factions, each with its own ideas about the perfect society.

Separate from these factions are individuals known as Minotaurs, political hermits who dedicate themselves to looking inwards rather than outwards. Your character is one such Minotaur, who emerges from exploring the innards of his mind to discover society has almost entirely crumbled, and decides to return to the Old City, where the water is purified and pumped to the three factions.

It's intellectually ambitious, combining biblical themes, political ideology and Cartesian philosophy regarding the nature of existence and reality. It's brimming with questions and ideas, but its biggest achievement is its environment design.

OVERALL SCORE

58%

/ VERDICT

Despite an intriguing premise and remarkable environment design, The Old City is let down by its impersonal approach to narrative.





aggressive evasion, although concessions have been made in the form of 'defensive items', one-off daggers and flashbang grenades that enable you to break a zombie's grip without taking damage.

The only enduring feature that could possibly have been cut is the use of the Ink Ribbons, which you need to save your game using the typewriters dotted around the map. The scattered save points make the game challenging enough, and adding a stringent limit to those saves shifts the focus of the horror from the events in the mansion to the status of your save file.

Still, it's unreasonable to expect a 20-year-old game to completely adhere to modern standards, and Resident Evil HD nevertheless does a fine job of updating a classic game without compromising its original design.

Seasoned survivors will approach Resident Evil HD's memorable set pieces with a joyful trepidation, while newcomers will likely be astounded by the creeping dread and explorative elements that were once hallmarks of the Resident Evil series.

RICK LANE



Leviathan frames its abstract contemplation within a world that's lovingly crafted and a delight to explore. Most of the game takes place in areas surrounding the Old City – barely functioning water stations, eerily sparse office complexes, abandoned dockyards littered with shipping crates and dead whales, and shadowy subway stations. Interspersing this decrepit reality are dreamlike visions of stunning cityscapes, each with a specific architectural style. All of these cityscapes are watched over by giant, symbolic Minotaur statues.

Precisely what the Minotaurs symbolise is difficult to say, though, because Leviathan's approach to storytelling isn't welcoming. It's written with the verbosity and structural complexity of an academic essay, which would be challenging to read, and is difficult to follow when narrated to you in big chunks. Worse, aside from a couple of



names on scraps of paper you encounter, there are no characters in the game with whom you can connect, and therefore no reason to care about any of Leviathan's philosophical ponderings. In terms of script, Leviathan is all mind and no heart, airy ontology devoid of substance.

Away from the story and the setting, Leviathan doesn't have much else to offer. Your interaction with the game world is limited to opening a few doors. There are plenty of additional clues and riddles hinting at the broader puzzle, such as writing and diagrams on the walls, and exhaustively long letters from someone named Solomon, but before you ask the player to solve an enigma, you must give them a reason to give a damn. Leviathan fails on this front so, despite obvious smarts and visual splendour, it's ultimately disappointing.

RICK LANE

NEO Scavenger / £10.99 inc VAT

DEVELOPER Blue Bottle Games / PUBLISHER Blue Bottle Games / WEBSITE <http://bluebottlegames.com>

OVERALL SCORE
87%

/ VERDICT

NEO Scavenger may look like it just crawled out of a dustbin, but a powerfully gripping survival RPG sits beneath the grime.

NEO Scavenger gets its hooks into you with fast starts and sudden stops. This functionally presented survival RPG deftly navigates a difficult balance of being easily accessible, yet brutally unforgiving and speedily paced, while being deeper than Richard Branson's pockets. It spins 1,000 unique stories. Very few of them end happily, but all of them are entertaining.

After quickly assembling your character from a selection of traits, occupations and flaws, you wake up in an abandoned research centre wearing nothing but a medical shift. Clambering through the window, you discover that civilisation is a crumbling ruin, with strange creatures and even stranger humans stalking menacingly through the rubble. In order to survive this punishing world, you must wade through the wreckage of humanity, and make use of whatever you can find.

What makes NEO Scavenger so gripping is the granularity of its survival simulation, and the number of considerations you need to juggle in order to stay alive. Hunger, thirst, warmth, fatigue, injuries and sickness are all simulated. Standing in the rain wearing just your hospital sheet will lead to hypothermia within a few turns, so finding clothing is your most pressing initial concern. Your carrying capacity is also precisely simulated. You have no inventory per se, but clothing such as jeans and hoodies have pockets in which items can be carried, while rucksacks, sledges and box-carts offer greater storage

space. Even empty crisp packets and plastic bags can be used to carry items.

Items are randomly generated, but the process of scavenging is affected by your choices. Scavenging strongly indoors increases your chances of finding something, but also increases your chances of injuring yourself inside a dilapidated building. Likewise, searching with a light-source is more fruitful, but may attract enemy creatures.

Combat is similarly presented. In each turn, you select an action, such as attack, retreat or a special move such as 'parry' or 'dodge'. The results of your actions are explained through unflinching text descriptions. The game's dynamic prose is elegantly simple and, when combined with the eerie soundtrack and precisely implemented ambient sound, it creates a rich, haunting atmosphere.

There's no correct approach to playing NEO Scavenger. Every action is a gamble that might pay dividends or trigger your immediate demise. Character death is permanent, but the initial setup plays quickly, and you learn more about the game's systems with each restart. The only downside to this system is that you may miss much of NEO Scavenger's wonderfully written story, and the many scripted events you can encounter throughout the world.

But NEO Scavenger puts *your* story ahead of its own, and has the systemic depth to make this setup work. In a sea of survival games, NEO Scavenger contends with the best.

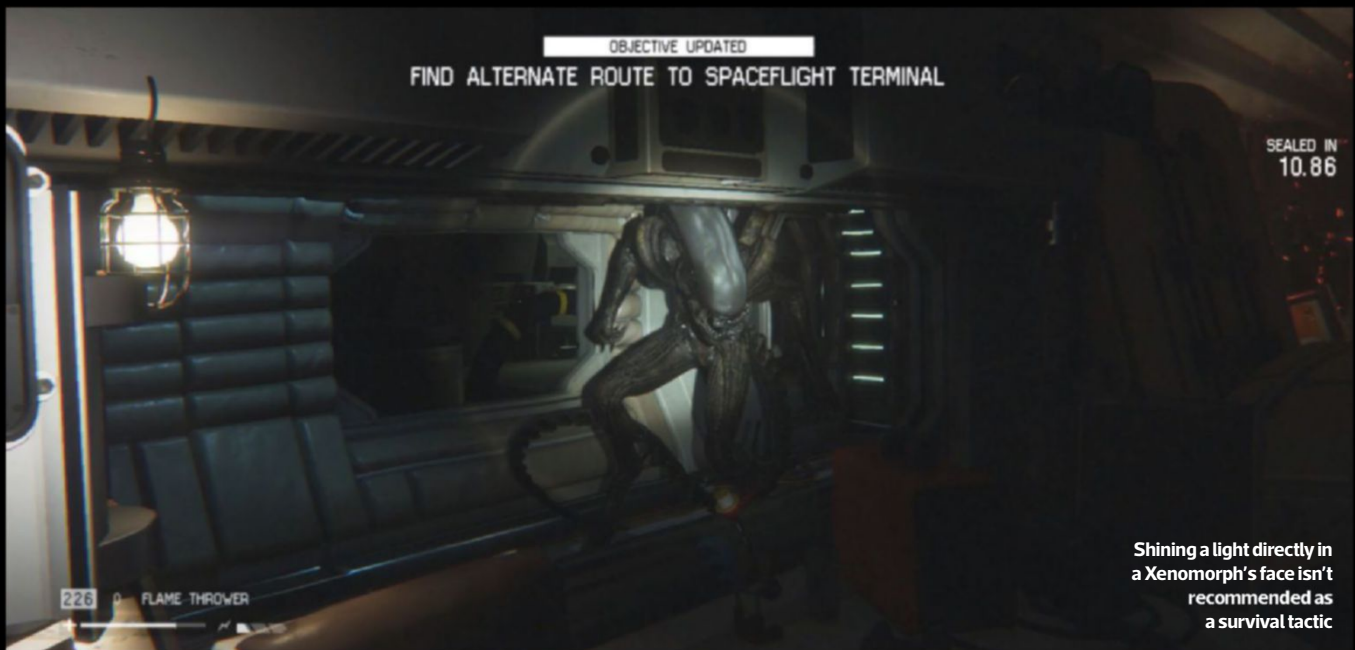
RICK LANE



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RICK LANE / THE ENGINE ROOM

Alien: Isolation

Rick Lane braves the depths of the Creative Assembly's horror masterpiece

Ridley Scott's *Alien* is one of the most visually iconic films ever made. The look and layout of the USS *Nostromo* is burned into the consciousness of anyone with even the most cursory interest in science fiction, as is the look and behaviour of its most notorious resident. Consequently, *Alien: Isolation*'s engine is focused on adapting this look and feel, retaining as much detail as possible, into a game scenario.

To have such a specific design goal before you've started building your technology is a rare challenge. Clive Gratton, technical director at the Creative Assembly, breaks down the engine's design goals into four strands. Lighting, durability, functionality and aliens.

'We wanted dynamic, believable lighting – to be able to change the lighting environment and have torches piercing the darkness,' Gratton says. The *Isolation* team also needed to ensure the engine was future-proof, suitable for hardware

that wasn't even announced at the time, and quickly updatable in terms of both game and engine features. 'Content iteration speed is vital for producing the quantity and quality of environments required for the game,' says Gratton.

We'll get to the fourth point on Gratton's list later. The other three all feed into the same ultimate goal: creating environments that are as true as possible to the films, and as realistic as possible using currently available technology. A major portion of this work was done with real-world research.

Sevastopol Station is heavily based on the architecture and technology seen in *Nostromo*; the chunky computer terminals, cream-padded hexagonal rooms and gleaming gunmetal corridors. Newer environments are adopted from real-world locations, including airport terminals with luggage conveyors and neon-drenched shopping malls.

In both cases, *Isolation*'s environments are rendered using a

physically-based approach. The *Isolation* team was given access to Ron Cobb's original concept art from the 1979 film, while all textures and materials were based on real-world objects.

'Believable materials, which stay believable under different lighting conditions, are another key requirement for making the world resemble the film,' Gratton adds.

From a purely technological perspective, the *Isolation* team used several processes to lend Sevastopol station an authentic look. The first was theoretically very straightforward – large amounts of geometry. 'We use polygons where many others would embed that detail in normal/displacement maps,' says Gratton.

Normal mapping is a graphical technique used to fake surface detailing, like the bumps on a stone wall. Instead, *Isolation* renders that detail in real 3D space, which is computationally more expensive but more convincing.

This image demonstrates Isolation's realistic light reflections off surfaces.



Isolation's lighting system allows the designers to move lights around in real time



'We also spent a lot of time recreating the look of the original film stock and processing,' Gratton says, listing a range of techniques the team used. 'They rendered flares as they would appear on an anamorphic camera lens used to shoot 35mm film, and matched the film grain, lens barrel distortion and colour grading of the original 35mm film stock as closely as possible.'

Perhaps the most important factor in the game's visual style is lighting. Like the material rendering process, the Creative Assembly's approach to Isolation's lighting was as much about real-world filming skills as engine tech. 'Once the sets were built, we had specific lighting guys (some from the film industry) who would, as a result of our bespoke engine tech, be able to load the level in the editor and then add whatever lights they fancied and see the results in real time,' Gratton explains.

The bespoke engine tech in question is Isolation's real-time radiosity system, which Gratton says reflects light off surfaces in a realistic way. 'This is normally a process that most games do offline, baking light maps to produce good-looking static lighting,' he explains. 'Our ability to do this in real time was key for authoring and allowing the freedom to turn lights on and off at will.' In other words, the Creative Assembly could treat each environment in its game like a film set, doing a 'take' and then switching the lights and in-game objects around until they produced the desired effect.

The environmental aspect of Isolation was only half the battle though. The other major component

of an Alien game is, of course, the alien itself. Again, the Xenomorph is both an aesthetic and atmospheric factor, but arguably more in a behavioural sense than a visual sense. The Creative Assembly wanted the player to feel hunted, and that meant having an unpredictable AI system that didn't rely on predetermined routines.

'Our basic premise for the AI was not to cheat,' Gratton says. 'A level is pre-processed to find interesting places for the Alien to search. We then drop it into the level with a few parameters to say how fast to search, as well as where and what size radius to use. If the Alien hasn't spotted the player, it will do a leisurely search of a large area. We have a very "honest" sensory system, so if the Alien sees or hears the player, it will know more information about where to search and how far it should search.'

Isolation's AI system isn't wholly dynamic. There are times during the story when the Xenomorph doesn't feature, or when the designers want the player to focus on something other than imminent death by scaly knife-monster. But the general rule is, if you can see or hear the alien, it can hear and see you.' Again, we're

(mostly) very honest with the AI. If you can hear the Alien in the vents close to you then there's more chance that it can hear you and will come down. It's actually traversing through the vent network. If the Alien has seen you at all, it will try to predict where you're going and either ambush or search for the you.'

The Xenomorph's AI is probably its impressive feature, but its visual design work shouldn't be ignored. The Creative Assembly notably changed the Xenomorph's legs, reversing the position of the knee so it looked less human and more like that of an ostrich, emphasising the creature's 'alien-ness' when hiding from it under a table.

But Gratton reveals several other interesting design problems the team encountered with the Xenomorph. The Xenomorph's tail is driven almost entirely by physics simulation, for example, with little to no animation involved. But the biggest issue was getting the Xenomorph's size to work with the environments. 'We wanted the environment to be small, so that it was claustrophobic,' he says. 'This made animation, AI and locomotion difficult at times because the character had to negotiate the world very accurately, so it didn't bump into doorways and look silly.'

It's difficult to say whether we'll see Isolation's tech again. Another Alien game is possible, depending on whether players want to brave that universe's sci-fi horrors again. However, Isolation's tech was built for a specific purpose, which could pose problems for flexibility. On the other hand, Isolation's design is based on a standard first-person framework, so adapting it for a broader range of games could be on the cards. **GPT**

Some scenes, such as the medical bay, are recreated almost precisely from the film





JIM KILLOCK / DIGITAL RIGHTS

The war against encryption and privacy

Jim Killock talks to cryptographer Ben Laurie about the government plans to snoop on Internet communications when a court order is present

Most people's first reaction to the Charlie Hebdo massacre was sympathy and solidarity in face of an assault on our liberty. But from British government, the second reaction was a call for new surveillance powers. David Cameron appeared to declare war on encryption, asking if 'we want to allow a means of communication between two people which, even in extremis with a signed warrant from the home secretary personally, that we cannot read?' Cameron's answer was 'no, we must not. The first duty of any government is to keep our country and our people safe'.

Cameron's demand seems initially reasonable. Why shouldn't the Home Secretary get access to messages when there's a warrant? I asked Ben Laurie, founding director of The Apache Software Foundation, and a cryptologist who works on Internet security technologies, including SSL, for his thoughts about the apparent battle between government and security technologists.

Laurie says, 'It's a bit like asking: "Why shouldn't the Home Office be able, with a warrant, to tell buildings not to fall on people?" It's physics. Court orders are apparently going to

magically enable a technology that means access would only take place when a court order is presented.' But any such system would mean that 'whatever you do, there would be a backdoor that anyone could use, which would be particularly dangerous when you're trying to protect people, and the backdoor is being used by your enemies rather than your friends'.

So why are politicians demanding the impossible? 'Politicians are the public too,' says Laurie. 'They don't have any special ability to understand these things, and the people that brief them don't have any motivation to tell them the downsides. I'm sure that GCHQ and the NSA are advising Cameron that it will work without problems.'

I put it to Laurie that Cameron might hope to use his 'reasonable' position of principle to push Internet platforms such as WhatsApp, and to stop providing 'end-to-end' encryption, where people can talk to each other, but the service can't listen to them. 'The best approach,' says Laurie, 'would have been not to pull the stunts that Edward Snowden showed they were pulling. Does Cameron not realise

the US companies now *hate* GCHQ?'

Laurie thinks US tech companies are likely to resist pressure for general agreements to spy on users and hand over data. He observes that, for the most part, agencies want metadata – the who, when and how of your communications – which is often accessible by tech companies, even when content isn't accessible. Even so, companies have been doing much more to protect user privacy since the Snowden revelations, which in turn is annoying agencies that have become used to being able to access the content and data of personal communications in bulk. So what's driving this change?

'It's a combination of outspoken user desire and a commercial desire to capitalise on Snowden,' says Laurie. 'Snowden has shaken loose a lot of funding for privacy tech and public paranoia.' These privacy-friendly changes go further than a few commercial applications. There's renewed interest in creating new, secure technologies. He points to efforts to make the metadata from communications hard to gather.

'The push is the same as for encryption in general; people don't want to be spied on. The wake of the



Snowden revelations is that people are realising that metadata is the only data that actually matters, and it's being collected on a huge scale, which makes people angry. That said, it's actually quite difficult to obscure metadata, so I'm not sure how successful that's going to be, but that's the way people seem to be pushing. If you look at the latest generation of messaging systems, such as Pond and BitMessage, they're designed to try make it impossible to know who is talking to whom.'

Other systems concentrate on protecting your address books, and providing methods to let you know that your friends are online, without revealing this information to the security agencies. Are they commercial or non-commercial?

'The projects that are trying to provide end-to-end anonymity, where I can talk to you but nobody knows I'm talking to you, are generally non-commercial at the moment. There's a good reason for that, which is that they're quite expensive in terms of resources, such as bandwidth.

'To provide a mass commercial service, you're going to have to pay for the resources, whereas free services tend to rely on the goodwill of participants who donate machine time or bandwidth.

'So, mostly, these services are open source and free to use. I don't know what their future is, but it's a trend that's growing. Use of Tor [the anonymous browsing system], for instance, is growing and growing.' These systems come with downsides though. Is the 'expense' that Laurie highlights also a cost to the users who operate the software?

'It's not normally more expensive for the users; the service providers pay the cost. With Tor, you do some extra computation on the user side, but ultimately, you're using essentially three times as much bandwidth, and it's other people in the network who provide it. If it was a commercial service, it would presumably cost users more, though, because providers would have to charge more for it.'

Another area of technology Laurie says is being developed is private information retrieval. The idea of this technology is to allow individuals to query a database, but ensure the database doesn't know what they're retrieving. This tech would allow you to interact with complicated technologies and services without the service getting to know everything about your requests.

'The obvious way is letting you get the whole database,' says Laurie, 'but can you do better than that?' He gives

the example of homomorphic encryption, which 'lets you get somebody else to perform a calculation on your behalf without knowing what you're calculating, by doing an equivalent calculation.'

This is important because it enables privacy-friendly, centralised information tools. One of the basic objections to encryption of end users' content, such as your photos or financial information, is that cloud-based services can't interact with the encrypted material. However, private information retrieval systems would enable you to obscure what and who is making queries, so you can effectively have your privacy cake and eat your cloud-based service.

Still, Laurie says that homomorphic encryption 'across whole databases is insanely expensive and not really practical at the moment'. There are more efficient ways of serving the same goal, he says, 'by asking two different servers two different things and combining the results to get the answer you want'. This system works as a privacy technology as long as the servers are trusted not to talk to each other to work out what you're doing.

All technologies can have downsides and limitations, says Laurie. 'Tor, in fact, is not that great against attackers who have a view of the whole network. If you wanted to make it great you would have to slow down users to provide truly good anonymity.' But the bigger picture, he says, includes institutional hypocrisy on the part of governments.

'There's a brilliant piece of doublethink going on,' says Laurie. 'The perceived need for privacy technologies is also perceived by governments. They would like people to not be using them, unless they're people who they would like to be using them. The people they *would* like to be using them are, for example, the military and covert operations, but also dissidents in countries whose regimes they don't approve of. So Obama funds Radio Free Asia, which funds the Open Tech Fund, which funds exactly the things Cameron wants to ban.' **GPG**



PC BUILDING MASTERCLASS

Contrary to popular perception, PC building isn't just like doing a jigsaw with circuitboards, particularly if it's your first build. Luckily, PC builder extraordinaire Antony Leather's masterclass is here to guide you through all the potential pitfalls

To most PC enthusiasts who have already built a PC, the thought of making one from scratch is similar to a walk in the park. Once you know where all the bits go, it's much easier.

If you find yourself feeling a little daunted, it's always worth remembering there are fewer than ten main components to install, and that in many cases, it's impossible to connect components incorrectly. Even installing Windows can be accomplished in less than half an hour these days, and we'll look at some great ways of getting all your favourite programs installed in record time too.



WHERE TO START

Whether or not you've built a PC before, the best place to start is our Elite list, which shows you all the parts you need for a variety of budgets and, best of all, we've only listed the best components that we'd also be happy to have in our own PCs. The first component to choose is the processor, which will be made by Intel or AMD, and slots into your motherboard.

A motherboard will support a specific range of processors from either Intel or AMD. The easiest way to check compatibility is by matching the processor socket to choose the right motherboard and processor – for instance, an AMD Socket FM2+ processor is compatible with a Socket FM2+ motherboard, while an Intel LGA1150 processor will only work in an LGA1150 motherboard. Online retailers list these facts in the specifications, which can be helpful.

The memory (either DDR3 or DDR4) is again specific to the motherboard and processor you

Start by deciding which components you want

use, although only LGA2011-v3 systems use DDR4 memory.

You'll also need a processor cooler, as the stock coolers provided with retail CPUs are universally noisy and comparatively inefficient – thankfully, most CPU coolers fit all the current sockets, but it's always best to check.

A power supply (PSU) is also needed to bring life to your rig – you just need to select one that's both powerful enough for your needs and has enough connectors for your components. For the most part, a 500–650W PSU is enough for systems with a single graphics card these days.

Windows is still key to using most PCs, and it will need its own home – either a solid state drive (SSD) or a hard disk (the former is faster, while the latter costs less and offers more storage, but is much slower).

You'll need a case to house it all too, and finally a graphics system. Many processors, including AMD's APUs and Intel's LGA115x chips, have their own built-in graphics processors, so a separate graphics card isn't necessary in such systems if you won't be playing games. For example, our Elite list all-purpose PC includes one of AMD's APUs, which even has enough graphics grunt to run some games at decent settings at 1080p. If you're a serious gamer, though, and want to crank up the eye candy, you'll also need a discrete graphics card to slot into your motherboard.

In addition, you may also want to consider a DVD or Blu-ray drive for software installation, while audiophiles will probably want a dedicated sound card to replace the motherboard's on-board model.

TOOLS YOU'LL NEED



PHILLIPS/CROSSHEAD SCREWDRIVER

This screwdriver is the one essential tool for PC building. Many cases have tool-free mounts for various parts, but you'll always end up needing a Phillips screwdriver for some tasks, especially mounting the motherboard, securing the processor cooler or installing the graphics card.



PLIERS

Needle-nose pliers are a very useful addition to your PC-building toolbox. The mounting systems for many CPU coolers, for instance, use small nuts that need fastening. In addition, snub-nose pliers are a little beefier and often come in handy in situations where more torque or grip is required.



CABLE TIES

Many PC cases offer some form of cable-tidying system, and some chassis have Velcro straps to tie down cables. However, a bag of cable ties won't cost you much money, and will really help you to gather up stray cables, improving your PC's airflow and the interior's tidiness at the same time.



WIRE CUTTERS

Wire or plastic cutters are not only great for dealing with your own cable ties, but also ties used on any hardware. Your case accessory box and power supply, for example, will likely have its cables tied up and wire cutters can help to free them – they're much easier to use than scissors or pliers for this task.

BUILDING A PC

01 INSTALL CPU

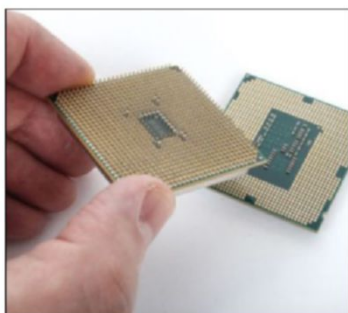
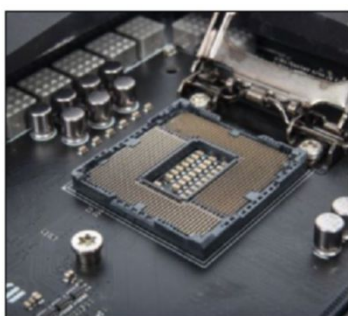
Your first job is to install the CPU, but if there's one warning we'll give you, it's to be very careful with the CPU socket pins on Intel motherboards after you've removed the protective plastic cover on the socket. They're incredibly fragile, and even if you accidentally drop the processor from a couple of centimetres into the pins, they're likely to be damaged beyond repair.

If you're using an Intel CPU, pull out and lift the handle, so you can lift up the socket cover. There are indentations on the bottom that indicate the correct orientation for it to sit in the socket (only one way is correct, but it's fairly obvious). Lower it into the CPU socket from the side, move it across and then slot it gently into place. You can then close the cover, and push the latch handle back into place to lock the CPU into the socket.

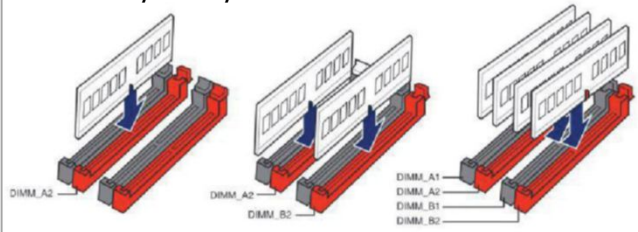
AMD CPUs, on the other hand, have the pins on the CPU itself. These pins aren't quite as delicate as those on Intel motherboards, but they still require care not to bend them. These pins slot into small holes in the CPU socket – the correct orientation is made obvious by the pin arrangement. Lift the handle next to the socket, to open up the holes for the pins, and then gently lower the CPU into the socket. Once the CPU is sitting firmly in place, push down the handle by the socket to secure it.

02 INSTALL MEMORY

Most motherboards have four memory slots, while the majority of memory kits only contain two sticks. Therefore, you'll likely have a couple of slots left over. You'll need to use the correct slots, though, and your motherboard's manual will indicate which ones you need to use (usually the second and fourth slots, moving away from the CPU socket) in order to enable dual-channel mode, where the two sticks



Find the recommended configuration for dual-channel memory mode in your motherboard manual



work in tandem to increase performance.

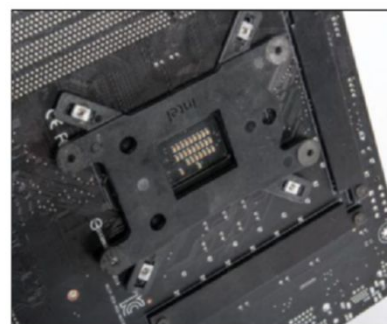
The memory can only fit one way in the slot due to a notch that's cut into its base. To install a memory module, flip up the clips on either side of the slot, put the memory module in place, and push firmly on the top of the module, in the middle, until the clips on the sides flip back up again – you can then clip them properly into place.

The only major difference here is with more expensive LGA2011-v3 systems, which usually have eight slots and require four stick memory kits to take advantage of their quad-channel mode. Again, if you're unsure of the correct slots to use, it will be well documented in your motherboard's manual.



03 INSTALL CPU COOLER MOUNT

CPU coolers use a variety of methods to be secured to your motherboard. The Corsair all-in-one liquid cooler we're using has a backplate that sits underneath the CPU socket on the rear of the PCB. It then uses a mounting plate and thumbscrews to secure the cooler to the CPU. Many air coolers use a similar method, but some have more involved fittings, especially around the CPU. Install any backplates first, before applying thermal paste to the CPU, or you'll get messy very quickly.



CPU SOCKETS AND CHIPSETS

Currently, there are a number of CPU sockets and chipsets that can make it tricky to understand which processors and motherboards are compatible with each other. Here's a quick guide to help you make the right choice.



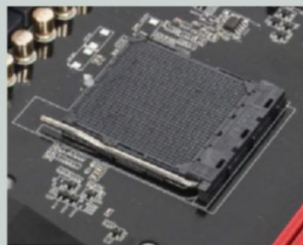
INTEL MID-RANGE CPUs

All of Intel's new low-end and mid-range CPUs use the LGA1150 socket. If your CPU is an unlocked K-series CPU (such as a Core i5-4690K) or the Pentium G3258, you'll need a motherboard that uses Intel's Z87 or Z97 chipset if you want to alter the CPU's multiplier to overclock it. Otherwise, you can usually save money, as there are plenty of cheaper LGA1150 motherboards available that use Intel's H81 chipset.



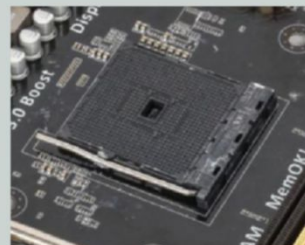
INTEL HIGH-END CPUs

If you're looking to build a 6-core or 8-core powerhouse, based on one of Intel's Core i7 5xxx-series CPUs, you'll need an LGA2011-v3 motherboard. These motherboards are based on Intel's latest X99 chipset, and also support quad-channel DDR4 memory. Meanwhile, Intel's socket for its older 6-core Core i7-3xxx and 4xxx-series CPUs is LGA2011, using the X79 chipset and triple-channel DDR3 memory.



AMD CPUs

Some of AMD's Athlon CPUs also work in the same sockets as its APUs. For example, the FX-860K will work in Socket FM2+ motherboards but, unlike AMD's APUs, it doesn't have a built-in graphics processor, so you'll need to invest in a separate graphics card if you use it. The most popular enthusiast AMD CPUs, such as the FX-6300, use Socket AM3+ and AMD's 9xx and 7xx-series chipsets.



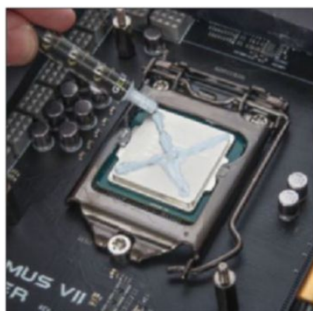
AMD APUs

AMD's latest APUs, which combine a CPU with a Radeon GPU, such as the A10-7850K, require a Socket FM2+ motherboard. Most Socket FM2+ motherboards use an A88X chipset. However, bear in mind that some of AMD's older FM1 APUs are also still available in the shops, and these chips will require a Socket FM1 motherboard, so make sure you get a motherboard with a socket that matches your APU.

04 APPLY THERMAL PASTE

As strange as it may seem, the surface of your CPU and CPU cooler aren't totally flat. Microscopic pits are present in each surface, which is bad news for dealing with the heat generated by your CPU. It's essential to use thermal paste or TIM (thermal interface material) to plug these pits, or your CPU will quickly overheat. Most CPU coolers include enough TIM to apply one or more doses, and many all-in-one liquid coolers have it pre-applied too.

High-performance thermal paste is also available from third-party manufacturers such as Arctic or Prolimatech, so you can always buy more paste if you run out. The best way to apply thermal paste is to apply a thin cross shape on the heatspreader. Tests have shown that the CPU cooler will do the rest for you, thanks to the pressure from the mounting mechanism, and this shape is best for achieving an even spread. To clean off any thermal paste, you can use isopropyl alcohol (available from chemists fairly cheaply) or Akasa sells various TIM cleaning solutions.



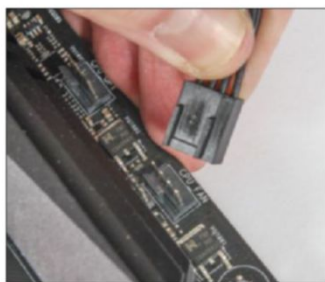
05 INSTALL CPU COOLER

All-in-one liquid coolers are actually easier to mount than many traditional air coolers these days, but mounting the cooler is undoubtedly one of the trickiest parts of the build process. Firstly, test-fit the cooler in your case – you'll need to mount the radiator section in a fan mount, preferably in the rear or roof of the case, so the fans are exhausting the hot air. This test fit will also give you an idea of the right way to mount the CPU cooler on the motherboard with the least stress placed on the tubing. Likewise, if you're installing a traditional air cooler with a large heatsink, position the heatsink so that the fan sits on the front of the heatsink, pushing air towards the back of the case.

Having applied the thermal paste, remove any plastic protective film from the CPU cooler base and line up the holes in the cooler mounting bracket. Holding it in place, attach the thumbscrews and



finger-tighten each one before moving around on opposite sides to lock them down fully. You can then connect the fans to your motherboard's CPU fan headers, and the pump and waterblock section to your PSU (or motherboard's fan headers, depending on the model).

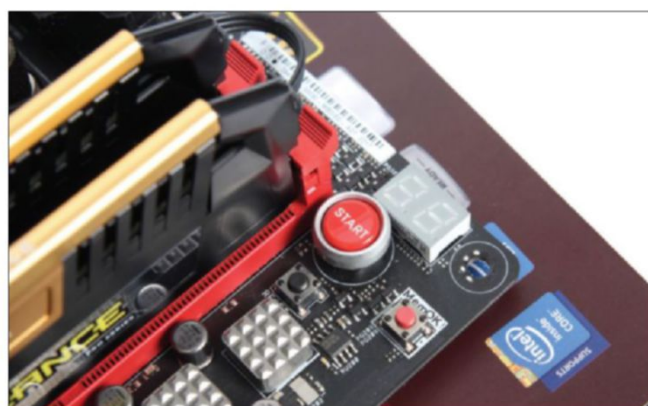


06 TEST PARTS



As with any electrical product, there's a very small chance that one of your components doesn't work, or you have a loose connection somewhere. To save wasting time building your PC only to find there's a problem, test this basic setup out of the case first. Lay the motherboard on a piece of cardboard, or its own box, and plug in a keyboard and mouse, plus your graphics card if you're using one. Now is also a good time to familiarise yourself with your PSU's various power connectors and where you need to connect them.

Connect all your components to the motherboard, and connect any SSDs or hard drives to the motherboard with SATA data cables. You can theoretically use any of the SATA ports on your motherboard to connect your storage drives, but it's worth identifying the SATA 6Gbps ports for your SSDs, as these will allow it to run as fast as possible. Check the motherboard's manual to identify them – they're usually coloured differently from the others. In addition, be sure to use those powered by either the Intel or AMD chipsets as third-party controllers are often slower.

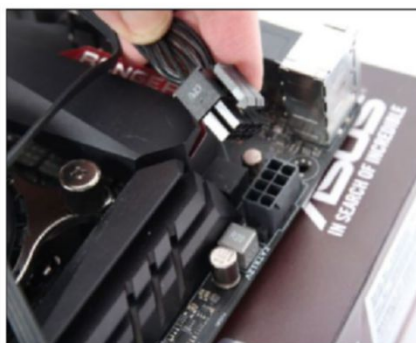


Also, you'll need to plug your monitor into one of your graphics card's outputs, depending on which type of cable you're using, or one of the motherboard's display outputs if you're not using a separate graphics card.

If your motherboard has on-board power and reset buttons, they will come in handy for this first test run. If not, locate the front panel header on your motherboard – a series of pins where you connect your case's power, reset, and LED cables for hard drive activity and power later, and your motherboard's manual will show you where it's located – usually at the base of the PCB. By shorting the power button pins with a small screwdriver, you will be able to turn on your PC without a power button (don't worry, it's perfectly safe!)



24-pin ATX connector (motherboard)



8-pin EPS 12V (motherboard near CPU socket)



SATA (hard disks, DVD drives and some CPU coolers)



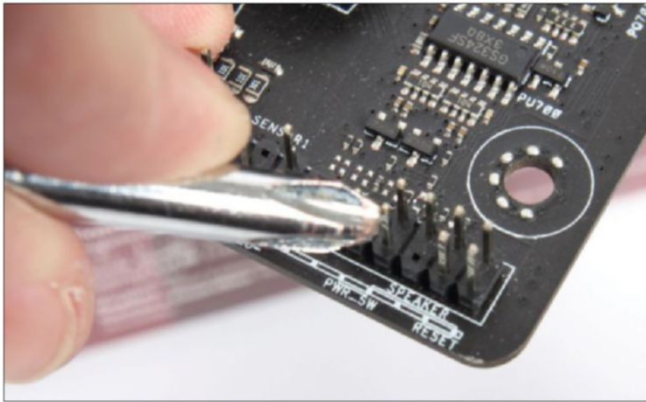
Molex (fans, fan controllers, pumps)



PCI-E 6-pin and 8-pin (graphics cards)



3-pin and 4-pin fans (motherboard fan headers)



When it boots, tap the Del key on your keyboard and you'll enter your motherboard's BIOS or EFI system – a piece of basic setup software for the motherboard. If you get this far, the majority of your hardware is working.

If you end up with nothing on the screen, power off the system, and try removing the memory, CPU and graphics card and then reseating them – there may just be a connection problem. If in doubt, borrow a friend's components that you know work, and try them one by one, so you can isolate the problematic component.

When you get into the BIOS or EFI system, there should be an information section that shows you what devices are connected to your PC. Make sure your storage devices are listed here – alternatively, they may be listed in the boot devices section.

While you're here, check your CPU temperature in the health or monitoring sections. If it's above 50°C, and you're using a good CPU cooler, it's too hot, so power off your system and check that you've mounted the cooler correctly, removed any protective plastic film from the cooler base and also applied thermal paste. The temperature should ideally be below 40°C at average UK room temperature.

07 INSTALL PSU

When you know your basic system works okay, it's time to mount it inside the case. Start by test-fitting the PSU and motherboard, so you can get an idea of which cables you'll need, and where you'll need to route them for your chosen setup, including any storage drives and the graphics card. Graphics cards use either 6-pin or 8-pin PCI-E power connectors from your PSU, although low-end models sometimes don't need extra power. It's worth taking some time to think this part through, before you finally screw the PSU into place.



Modular PSUs will often have more connectors than you need, so it's definitely worth consolidating them down so you're not pointlessly storing cables in your case. Make use of any cable-routing holes in your case too, especially for cables going to the motherboard.

08 MOUNT MOTHERBOARD AND COOLER



While it's often theoretically possible to install a CPU cooler after you've installed your motherboard, it's always easier to mount the cooler first.

Start by installing the motherboard's rear I/O shield in the back of the case, which will be in your motherboard box, and also removing any unwanted expansion slot covers – you'll need to remove these covers for any graphics cards or sound cards you're using.

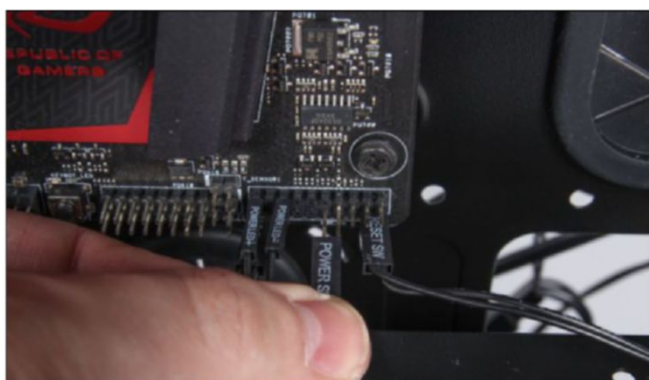
You can then install your motherboard, supporting your CPU cooler's radiator with your hand while you do so. Use all of the mounting points possible to secure the motherboard to the case, and make sure that every mounting hole sits on top of a standoff (so you don't short out your motherboard) – these standoffs look like screws with another screw-thread in the top, and they will be supplied with your case. Likewise, make sure that no standoffs sit under a part of the motherboard that doesn't have a mounting hole, or you could end up short-circuiting the traces on the back of your motherboard.



The radiator will probably need just four screws that either secure the rear fan to the case or the radiator itself. Either way, mounting a radiator is usually fairly easy, but make sure the fan is blowing air out of the back of the case. The rear of the fan usually has a coloured label on it with the fan's specifications, as well as several long, thin supports.

09 INSTALL CASE CONNECTORS

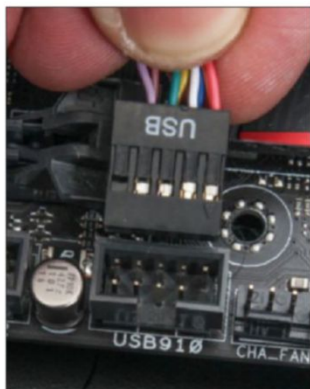
Cases often include a plethora of cables that connect to your motherboard. These cables allow you access many of case's features, such as front-mounted USB ports and audio jacks, as well as the power and reset buttons. We've shown some of these connectors below so you can identify and connect them to your motherboard.



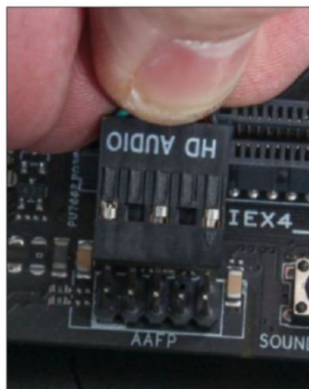
Power, reset, hard drive LED and power LED headers – they connect your case's buttons and lights to the motherboard



USB 3 connector – connects your motherboard to your case's USB 3 ports



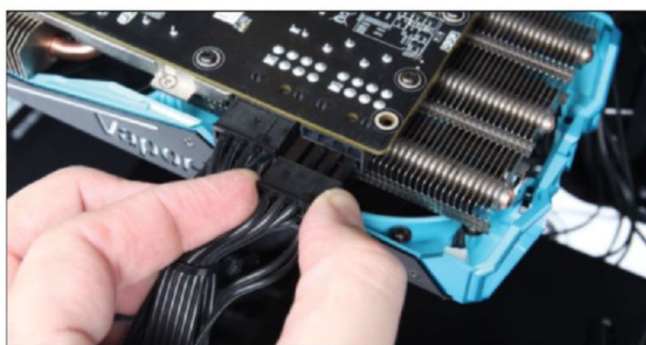
USB 2 connector – connects your motherboard's on-board USB pins to your case's USB 2 ports



Audio header – connects your case's audio jacks to your motherboard's on-board audio pins

10 INSTALL GRAPHICS CARD

Your graphics card needs to be slotted into the top large PCI-E slot (usually the first or second slot below the CPU). It will slot into place and you can then secure the expansion slot bracket to the back of the case.



11 INSTALL DRIVES

SSDs and hard disks mount in various ways, depending on the case you'll be using. Many need to be secured inside brackets first, while others simply slot into a cage in the case. If possible, position any SSDs out of the path of any fans to improve cooling, but hard disks get warm, so point a fan at any hard drives if possible. Rotate the drives so that the connectors face away from you as you look at the case side-on, which will make it easier to build a neat system.

SSDs have recently been getting their own dedicated mounts in many cases, but some cases still require adaptors for them to fit in 3.5in hard disk bays. Whichever method your case uses, installation of 2.5in and 3.5in drives should be well-documented in the instructions.

Meanwhile, DVD or Blu-ray drives will be mounted in the front of the case using a 5.25in bay. You sometimes need to pry out a metal





blanking plate at the front of the case behind the panel covers first. You'll then be able to remove one of the covers before sliding your DVD drive into place. Some cases will have tool-free mounts here that clip the drive into place. Otherwise, your case will include the appropriate screws needed for installation on either side of the drive.



12 CABLE TIDYING

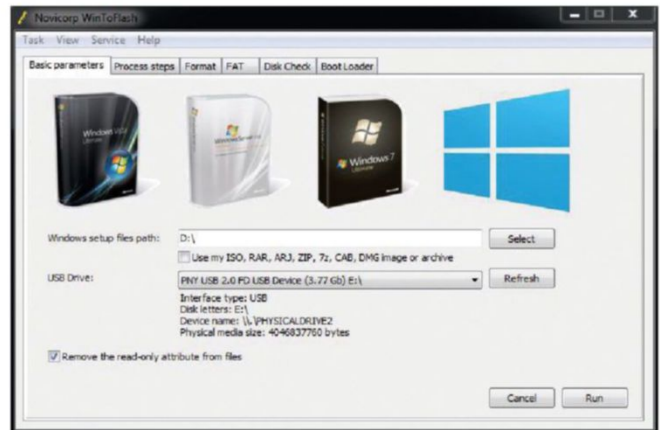
Once you've threaded your PC's cables through its innards and connected all your hardware, spend some time tidying the cables. This process will not only make your PC look neater but it can improve airflow too. Some cases will have cable ties or Velcro straps, but it's worth investing in a bag of cable ties of various sizes so that you can tie down as much as possible. If straps don't float your boat, www.kustompcs.co.uk offers a variety of cable anchors that you can use to group stray cables together.



13 CONFIGURE BIOS OR EFI AND INSTALL WINDOWS

Power on your PC to check that it's working (if not, as before, check all your connections and try reseating any components). Assuming it all works, you can now think about installing Windows. Firstly, a far better option to installing Windows from a DVD is to use a program called Wintoflash (<http://wintoflash.com>).

This app copies the entire Windows installation from your DVD to a 4GB or larger USB stick, massively reducing the time it takes to install Windows. The downside is that you'll need another PC or laptop to do this job, as your PC isn't working yet. If you (or a friend) has another PC or laptop equipped with a DVD drive, then follow Wintoflash's simple wizard to create your USB installer. Alternatively, you can of course just use a Windows DVD.



Insert either your Windows DVD or USB stick, reboot the PC and boot into the Windows installer. Some motherboards have the option to select your boot device on their start-up screen – if so, select your DVD drive or USB stick and proceed into the Windows installation. If not, head into the EFI or BIOS by tapping the Del key on your keyboard when your PC starts, find the boot section and set the first boot device as either your DVD drive or the USB stick – whichever one you're using to install Windows.



In the Windows installation, select the right language, then there should be the option to install to a specific disk. If you're using an SSD and a hard disk, install Windows onto the SSD. Select the SSD from the list then click Next – you don't need to create a new partition, as Windows will do this job for you. The PC will eventually restart, at which time you should remove the DVD or USB stick, and set the first boot device to the drive on which you're installing Windows.

Once you're into Windows, install your motherboard's Ethernet or Wi-Fi driver, get your new machine online and download the latest Windows updates. Again, you can either use the driver disc that's included with your motherboard or download the file you need on another PC, from the motherboard manufacturer's website, and transfer it using a USB stick.

Once all the Windows updates are installed, proceed with installing the rest of the drivers for your components, starting with the motherboard chipset driver, and then the rest, including the latest AMD or Nvidia driver for your graphics card. **GPC**





EXPLORING ELITE DANGEROUS

Custom PC's guide to the galaxy

Elite Dangerous simulates some of the most dazzling sights in the Milky Way. Rick Lane's virtual tour guide explains where to see them

Elite Dangerous simulates a galaxy of 400 billion stars. The majority of these stars' systems are procedurally generated by algorithms based on our scientific knowledge of how space works. But 160,000 of these systems are based on real stars that can be seen from Earth, be it in the night sky, or using powerful telescopes. What's more,

because of Elite's scientific basis, you get a fairly accurate representation of how these stars look in terms of positioning, scale and hue. From barely luminescent brown dwarfs to planet-eating red giants, these stars are orbited by planets, which in turn are orbited by moons.

Assuch, Elite provides a fascinating opportunity to explore our own

knowledge of space, and educate ourselves about what precisely exists beyond our solar system. Where's our nearest pulsar? Just how big is a red giant? What would it be like to fly around a black hole?

In this article, we'll answer those questions and more, covering what you need to take to the virtual skies yourself, and where you should go to



A lava planet orbiting a standard M-class star

see the most incredible sights our galaxy has to offer.

Getting started

Through a combination of clever instancing trickery and level-of-detail phasing, Elite Dangerous represents the Milky Way on a scale of one to one. Travelling between stars is achieved through Hyperspace or 'Frameshift' jumps. Depending on which ship you use, the distance you can jump varies. The starting Sidewinder vessel can jump between eight and 15 light years in a single bound, while the Asp explorer spacecraft has the largest jump-range of roughly 36 light years.

That may sound like a long way, but the Milky Way is a whopping 120,000 light years in diameter. Factor in refuelling stops and the high possibility of being distracted during your journey by a pretty planet, and you'll quickly discover that getting around in Elite Dangerous takes time. Using a Cobra Mark III with a jump range of just under 25 light years, at Custom PC we normally

find travel between 200 and 300 light years an hour.

The other important factor to consider is price. Kitting out a decent exploration ship costs credits, which you'll need to earn in-game by completing missions, fighting pirates, performing trade runs, and discovering stars and planets of your own. The price will vary depending on what you buy and where, but a Cobra Mark III with a powerful jump drive, a power supply that can cope with it and a fuel tank with sufficient capacity, will easily set you back half a million credits.

For the purposes of this article, we've taken these factors into account, categorising the various places of interest by their proximity to our solar system. Short-range exploration (within a 300 light-year radius of Sol) can be achieved in any ship with a jump range of greater than 10 LY, and should only require an evening or two. Medium range (300-1,000 light years) requires a vessel with at least a 20-25 LY jump range and a free weekend. For long-range exploration, (greater than 1,000 light years) you'll need the best exploration ship money can buy, and plenty of time to dedicate to the game.

Regardless of which ship you use, you'll definitely need a Fuel Scoop, which lets you skim hydrogen off the surface of a star to refuel your ship. This process is frankly a little dull, but it's also free and prevents you from getting stuck in systems without a space station.

We also recommend investing in the best discovery scanner you can afford, so you can earn a few credits by scanning systems as you pass



The largest star in the galaxy, VY Canis Majoris, is almost three times as far from Sol as Betelgeuse

through them, and stop off if you see anything particularly interesting. Finally, because Elite is a simulator, there are substantial periods of time spent cruising, so prepare some music or a podcast to entertain you. Depending on your mood, we recommend the soundtracks to the recent sci-fi films Interstellar or Guardians of the Galaxy to spice up your space travel. Are we all set? Perfect. Let's lock in the coordinates, and make the jump to light speed.



Short-range exploration Cold stars, giant dwarfs and twin suns

Our galactic tour starts from Sol, to ensure you can find your way home. It's worth looking around our solar system anyway, to witness Frontier's vision of our backyard in the year 3300. Points of interest include a terraformed Mars, the snazzy Galileo station orbiting the Moon, the hulking Capital ship stationed just outside Earth's atmosphere, and being able to fly among the rings of Saturn.



Once you've finished, it's time to hit the Frameshift drive. A mere seven light years from Sol is one of the weirdest phenomena in our galaxy. The attractively named WISE 0855-0714 is the coldest-known star in the universe. This brown dwarf has a temperature of -13°C and, while it isn't the most spectacular sight in Elite, it's difficult to believe that this blue-purple sphere is in fact a star.

Then, 18 light years from our Sun is the Stein 2051 system, home to the nearest white dwarf star to our sun. Known as Stein 2051b, it's a little more visually impressive than WISE, its milky-white glow looking like that of an especially bright full moon. This system also contains a red dwarf star, which are fairly common throughout the galaxy. But if you haven't seen one, Stein 2051 is a good place to cross both star classes off your list.

A little further out, 20 and 40 light years respectively, are Wolf 562 and Rho Cancri. These systems aren't of

The Maia system contains just about every stellar and planetary formation possible

An incredibly rare yellow hypergiant, X Carinae is a target for dedicated explorers only

interest so much for their stars as their planets. Wolf 562 is orbited by a 439°C ice planet, while Rho Cancri is home to a planet suspected to be made almost entirely of diamond. Unfortunately, Elite doesn't recreate real planets quite as well as real stars, primarily because we know so little about exoplanets apart from their locations. Nevertheless, they're so close to Sol that it's worth visiting, if only to satisfy your curiosity.

Around 150 light years from Sol is another strange phenomenon. HIP 40977 A is an enormous S-class star, resembling a brown dwarf but around 200 times the size.

You can always tell a vast star in Elite Dangerous by how it appears when you first enter a system. Sun-size stars will rapidly grow in your cockpit window as you exit Frameshift, almost as though your screen is zooming in on it. Very large stars, on the other hand, don't seem to grow at all, as they're so huge that the distance travelled in your decelerating final approach makes very little difference to their appearance.



The 300 light-year radius around Sol is also home to two lovely contact binary systems. Contact binary systems are two stars located so closely together that they share a stellar envelope. As a result, they exchange matter between one another, which is the stellar equivalent of holding hands. The closest is W Ursae Majoris. Roughly 160 light years from Sol, it's a contact binary system comprised of two brilliant yellow stars.



Medium-range exploration Hypergiants, black holes, nebulae and pulsars

If you have a ship that can jump around 25 light years, and a fuel tank that only requires refilling every 7-10 jumps, you can witness examples of almost every type of stellar phenomenon in a fantastic 2,000-light-year grand tour of the galaxy.

Beginning at Sol, set a course for Betelgeuse, which is approximately 600 light years away. We say 'set a course'—one of Elite Dangerous' more irksome idiosyncrasies is that it can only plot routes on the galactic map in increments of 100 light years. Even then, it takes a few minutes to calculate the route, and you'll have to recalculate if you accidentally switch back to the game. Also, ensure that you have the navigation tab set to Fastest routes, and not Economical routes. Fuel consumption increases exponentially as you make bigger jumps, so you can negate this issue by making lots of little jumps. The downside, of course, is that it then takes ages to get anywhere.

You can either go straight to Betelgeuse or, if you're travelling at a more leisurely pace, there's plenty to see along the way. Stop off at the Bellatrix system, which is the right shoulder of the constellation Orion, if you want to see a particularly lovely example of a bright blue star. Meanwhile, the system 14 I Orionis contains an incredibly ostentatious-looking ringed planet.

Eventually you'll arrive at Betelgeuse, the left shoulder of Orion. Betelgeuse is one of the largest observable stars in the night sky, and by far the largest star within easy

reach in Elite. It's so big that initially you'll struggle to comprehend the scale. To give you an idea of its size, if Betelgeuse was at the centre of our solar system, it would consume every planet as far out as Jupiter. It's possible to get a sense of Betelgeuse's size in Elite too. Try flying out to some of the orbiting planets (which are predictably all balls of superheated lava) and watch as the star simply refuses to shrink in your cockpit window. Even 500 million kilometres out, it's like having a bright orange beach ball sitting on your dashboard.

Once you've marvelled at the mighty Betelgeuse, set a course for the Maia system in the Pleiades Nebula (also known as the Seven Sisters cluster). This journey will take you towards the bottom plane of the galaxy by approximately another 500 light years, but it's absolutely worth the trip. The Pleiades Nebula provides a very different backdrop to the familiar black of space, and the Maia system is one of the most bizarre and complex systems we've encountered. Stars of half a dozen different types seem to be flung about in random directions, all within easy reach of one another. But the main reason to come to Maia is not for the cluster surrounding Maia A, but for Maia B, which is a black hole.

There's a problem when it comes to visiting a black hole, which is that you can't see it directly. Instead, you need to fly as close as possible to it before your ship's emergency stop kicks in, and then adjust your course so that you're flying around it. If your positioning is correct, you'll see a curious lensing effect as the black



The reddish haze in the background is the dust from the Pleiades cluster

hole's gargantuan gravitational pull bends the light between you and it.

At this point you have a choice. If you like, you can travel around another 60 light years to PSR J0108-1431, which is the nearest pulsar to earth. Pulsars are incredibly dense collapsed stars (neutron stars). Around the size of a basketball, they spin rapidly and emit beams of electromagnetic radiation. In theory, they're an even more stunning sight than black holes. In Elite Dangerous, however, they're simply tiny dots of light that melt your ship before you can get close enough to observe them, which is rather disappointing if admirably realistic.

But the PSR J0108-1431 system is worth visiting anyway for two reasons. Firstly, like Maia, it plays host to a strange constellation of other stars. Also, it's at the base of the galaxy, so you can experience a powerful contrast between the star-crammed galactic core on one side, and the inky blackness of deep space on the other.

Whether you visit the Pulsar or not, at this point it's best to head back towards Sol. If you have time, stop off at 25 Ceti to see arguably the most remarkable binary systems in Elite, including a Sol-like star set against a

A beautiful contact binary, W Ursae Majoris is easily accessible from Sol

similar-looking star around 30 times the size. Lastly, drop into Arietis Sector YE-R B4-1 B to see a rare T-Tauri star, a shimmering white sphere that's still in the process of formation.



Long-range exploration Colossal stars, old supernovae and the light of a million suns

You've now experienced a good sample of what lies beyond the gravitational pull of our Sun. But if you have the patience and desire to explore further, there are plenty more astonishing sights in the far reaches of space. The largest star in the galaxy, VY Canis Majoris, for example, is 1,700 light years from Sol. This red hypergiant makes Betelgeuse look like a baby. Be careful around it, though, as it's possible to fall straight into the star when exiting Frameshift in the system. Meanwhile, X Carinae sits 6,700 light years out, and is an arguably even cooler star, being a yellow hypergiant – a rare formation that occurs before a star cools to the more familiar shade of red.

There are currently no visible supernova in Elite Dangerous, but the Eor Auscs sector, towards the galactic core, sits in a vast cloud of dust from a previous supernova. Going towards the galactic core puts you in the procedurally generated part of Elite's galaxy, of which Eor Auscs is part.

But what's authentically realised about the galactic core is its sheer number of stars. The environment changes completely, shifting from a star-pocked void to a dazzling light show as thousands of stars jostle together. Finally, if you can make it to the very centre of the galaxy, roughly 40,000 light years from Earth, you'll be rewarded with a view of the supermassive black hole around which the entire Milky Way spins.

Of course, this brief introduction to Elite Dangerous' galaxy represents only the tiniest fraction of Frontier's game world, and indeed the Milky Way. Elite is constantly being updated too. At the time of writing, Frontier added several 'Goldilocks zone' exoplanets, the discovery of which was announced only at the beginning of 2015, so there will be plenty to explore in the future as well. **GPD**





GARETH HALFACREE'S

Hobby tech

The latest tips, tricks and news in the world of computer hobbyism, from Raspberry Pi, Arduino and Android to retro computing

TUTORIAL

PirateBox

This month I finally found the time to build a PirateBox out of a TP-Link pocket router I purchased some time ago for that very purpose. For those not familiar, a PirateBox is a Wi-Fi access point that provides anonymous access to chat, forum and file-sharing features completely disconnected from the Web. Its name suggests various naughty copyright-infringing purposes, but a PirateBox is handy for perfectly legitimate reasons too: my main intention is to use the pocket-sized device to share files and collaborate during conferences and events.

I'll be using the TP-Link MR3020 router for this build, although other TP-Link routers can be used in its place, including the MR3040 with its built-in battery, or you can install the software on various other devices, including the Raspberry Pi. For full compatibility details, visit <http://piratebox.cc>

1 Download PirateBox

If you're using compatible TP-Link devices, you'll need two files to install PirateBox: the installer archive and a firmware specific to your router model. Both files are available from <http://tinyurl.com/tpbox> – download the top file, install_piratebox.zip, then search



for your router model (and, if applicable, hardware revision number) and grab the relevant factory.bin file.

Put the latter file in the root directory of a FAT-format USB drive, which will double as the PirateBox's storage device when it's running, then extract the install directory from the archive and put that folder on the device as well. Eject the drive, and plug it into the router's USB port.

If you're a Windows user, you'll also need a copy of PuTTY, which you can download and install from <http://tinyurl.com/p2r>

2 Prepare the router

Put the router's mode switch into the 3G (or 3G/4G on some models) position. You'll need to configure the router in its stock firmware to begin the installation process. The safest way to do this job is to connect it directly to your PC via the bundled Ethernet cable; it's possible to use the Wi-Fi connection instead, but not recommended. Either way, power up the router, point your browser at the

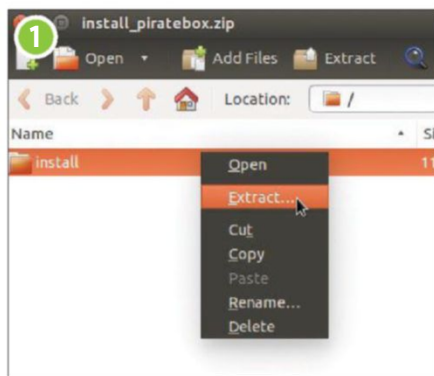
default IP of 192.168.0.254 and log in as admin, with the password admin.

Click on System Tools, then Firmware Upgrade. Browse to the factory.bin file you downloaded earlier, and double-check you have the right model and hardware revision before clicking on Upgrade. The upgrade will run and then the page will time out on reload. That's normal, and you can close your browser.

3 Configure PirateBox

The new firmware you've uploaded will look

 This symbol means the command should all be on one line



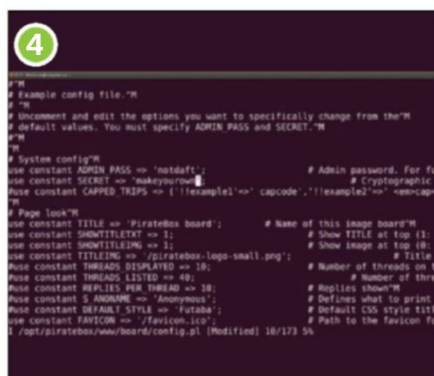
You need to extract the 'install' folder to a USB drive, but the factory.bin file can be copied straight across



Installation is straightforward, requiring little more than uploading a custom firmware to the router



When you see a cocktail recipe, you're ready to start configuring the PirateBox



Choose a decent password and secret for your forum's administrative user



MiniDLNA allows you to stream video and audio files to compatible client devices



Anyone connecting to the PirateBox's Wi-Fi will be forwarded to the welcome page

for the PirateBox installation files on your USB storage drive. You should see the drive's status LEDs flash as files are copied to the router; if not, it's possible the router doesn't like your particular drive. I went through three spare flash drives before finding one that worked; just copy the installation directory and firmware to a new drive and swap it for the one in the router until it works. Installation at this point can take up to 45 minutes.

To configure the PirateBox, open a Telnet connection from your PC with the following command:

```
telnet 192.168.1.1
```

Note the new IP; that isn't a mistake, but the default IP for a PirateBox. When the OpenWRT prompt appears, type:

```
box_init_setup.sh
```

This command loads a quick-setup menu. Press 1 to set an administrator password, and make it a good one; press 2 to set the date and time. When you've finished, pressing Enter will return you to the command prompt ready for the next step.

4 Enable Kareha

PirateBox comes with a pre-installed image and message board, called Kareha, which is based firmly on the design of 4Chan and similar sites. By default, it's disabled and

requires manual configuration before it becomes available to users. At the command prompt, type:

```
vim /opt/piratebox/www/board/ config.pl
```

If you're unfamiliar with the excellent Vim text editor, don't worry; its reputation for complexity is undeserved. Enter the edit mode by pressing i, delete the initial hash from the lines ADMIN_PASS and SECRET and fill them in according to your whims. Press Escape, then :wq followed by Enter to save and quit. You're done; Kareha is now available.

5 Enable MiniDLNA

Another optional feature of the PirateBox is UPnP-compatible media streaming via



I used a TP-Link MR3020 router for this build but other TP-Link routers can be used in its place

MiniDLNA. If you're not planning on uploading video, audio or image files, you can skip this step, otherwise you'll need to copy across the sample configuration file to its permanent home with the following command:

```
cp /opt/piratebox/src/openwrt.example.minidlna /mnt/ext/etc/config/minidlna
```

You can edit this file to configure it to your particular liking if you desire, although the default settings will work fine. Finally, start the MiniDLNA server and configure it to load on each boot with the following two commands:

```
/etc/init.d/minidlna start
/etc/init.d/minidlna enable
```

6 Use the PirateBox

At this point, you can disconnect your Ethernet cable. The whole point of a PirateBox is that it's disconnected from both the Internet and your own network, and operates entirely independently. To use it, you'll need to connect to the wireless SSID PirateBox - Share Freely. Once connected, load piratebox.lan to see the welcome page. This includes a brief description of the PirateBox project, a place for users to upload and download files, a link to the Kareha message board and an instant messaging system. Because the PirateBox is only accessible via its Wi-Fi network, nothing stored on it will be exposed to the Internet.

REVIEW

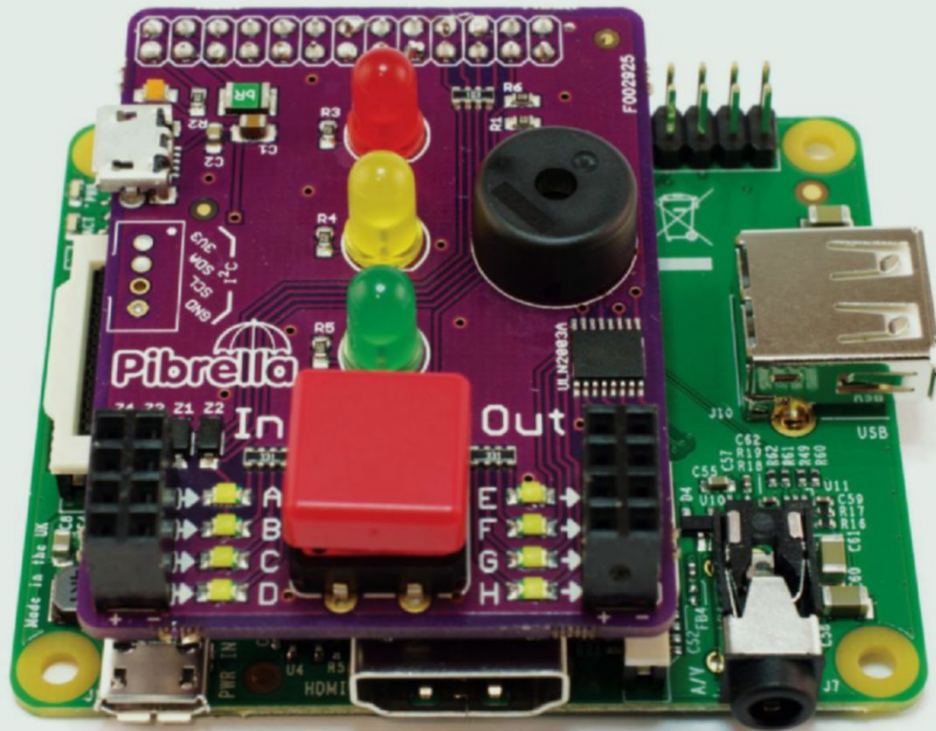
Pimoroni's Pi Products

I've had a bit of a bumper month when it comes to devices to review, after a visit to the Sheffield-based home of Pimoroni resulted in a bag of goodies for the test bench. Rather than spreading them out over future columns, I've instead opted to take a look at them all together – simply because they're all accessories for the Raspberry Pi, and they all light up.

PiBrella / £10 inc VAT

One of Pimoroni's oldest in-house creations, created in partnership with Cyntech, the PiBrella is designed as an aid to education. Surprisingly, given the company's love of tiny surface-mount components, the lighting-up part of this accessory is a trio of more traditional through-hole LEDs in red, amber and green, arrayed in traffic-light format. When connected to any Raspberry Pi's GPIO header, these lights can be controlled programmatically. A piezoelectric buzzer provides similar support for easy beep and boop sounds.

Output is only one of the PiBrella's tricks; a large and satisfying square button provides a simple input, while four additional inputs and outputs – complete with surface-mount LEDs for at-a-glance indication of their status – are provided on female headers at the bottom. The major selling point of the PiBrella, however, is its dedicated micro-USB power connector. By connecting a decent PSU to this port, rather than to the Pi, the usual



The PiBrella's compact dimensions belie a surprisingly comprehensive set of features

weedy GPIO power limits are bypassed, which is a boon for anyone hoping to experiment with motors, solenoids or similar high-current devices.

PiGlow / £9 inc VAT

The PiGlow is absolutely tiny, being even narrower than the GPIO connector itself and, while it costs £1 cheaper than the PiBrella, it lacks any input capabilities at all. That's by design: the PiGlow, as its name suggests,

in an output device bedecked with surface-mount LEDs in a rather pleasing triple-spiral pattern. Each of the 18 LEDs – three each of red, orange, yellow, blue, green and white – can be addressed individually, and while they lack the retina-searing

brightness of some of Pimoroni's other designs (step forward, the Unicorn HAT), they're more than bright enough to be seen reflecting off a wall when the Pi is mounted behind a display.

After I'd finished making the board display pretty patterns, the only real criticism I could find for the PiGlow is that it takes up the entire GPIO header of the original Raspberry Pi models, preventing other hardware from being connected at the same time. Owners of Plus models, however, can retain access to the extended I/O pins.

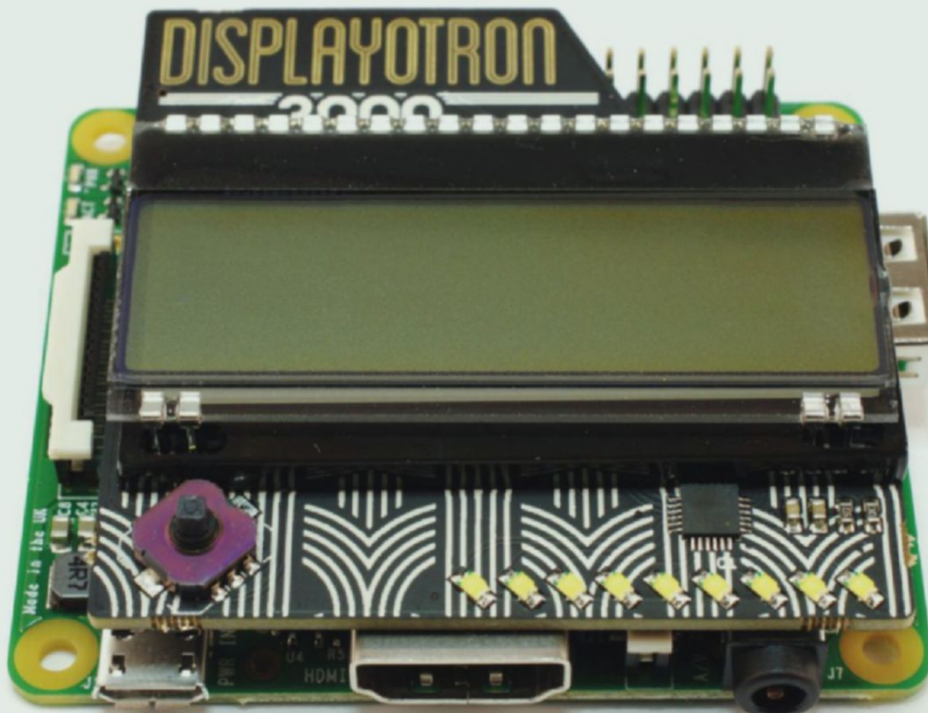
Displayotron-3000 / £24 inc VAT

The Displayotron is Pimoroni's answer to the excellent PiFace Control & Display, which I reviewed back in Issue 127. Like its rival, the Displayotron packs an LCD and a navigation joystick input, and it's designed to provide a user interface where the Pi – of any model – is embedded away from a traditional display or keyboard.

Whereas the PiFace has a 2 x 16 LCD with a single-colour light, however, the Displayotron has a 3 x 16 display featuring three independently addressable RGB LEDs for



If you only want to show pretty lights, the PiGlow offers a great way to do it



My pick of the bunch, the Displayotron-3000 is perfect for embedded applications

lighting – a considerable improvement. The additional buttons of the PiFace are lost in favour of having nine bright-white LEDs arranged in bar-graph format, while a five-way navigation stick acts as an input.

The Displayotron is undoubtedly my favourite of the products on test. It's genuinely useful yet attractive, and significantly slimmer than the PiFace C&D – helped by a clever LCD panel arrangement and the use of a low-profile connector for the

GPIO header. The example Python programs provided are excellent, and allowed me to quickly experiment with the board.

Unicorn HAT / £24 inc VAT

If there was ever a product that highlighted Pimoroni's love of kit that glow in the dark, it's the Unicorn HAT. Designed to conform to the official Raspberry Pi Foundation's Hardware Added on Top (HAT) specification, the board is

exclusively compatible with the Model B+ and A+ variants. An on-board EEPROM identifies the board to the host operating system – not that this functionality is used yet – while it uses the entire extended GPIO header.

Attaching it to a non-Plus Pi is possible, but will require some warranty-voiding modification and it's far from recommended.

Assuming your Pi is compatible – and you're not using the analogue audio output, as the Unicorn HAT will introduce considerable noise – the board provides 64 WS2812B RGB LEDs in an 8 x 8 grid. Each LED can be addressed individually, and considering they're powered by the Pi itself, they're blindingly bright. However, if you're using a power supply with less than 2A on hand, you may find your Pi crashes when all the LEDs are lit. Their response is rapid too, meaning they can easily be used for animation, or as a low-cost, network-controlled lighting system in the manner of a Philips Hue.

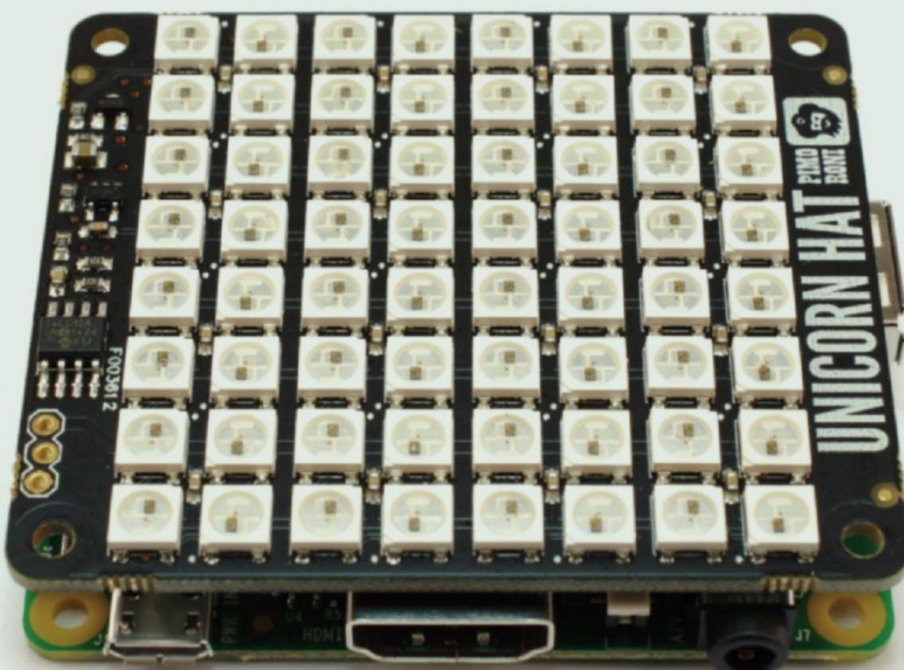
All the Pimoroni boards are available now from <http://pimoroni.com>

NEWS IN BRIEF



Intel announces wearable computing module

Intel is expanding its embedded product range with science-themed names, announcing a new module for wearable computing projects dubbed Curie. Based on a next-generation ultra-low-power variant of its Quark processor, retaining the Pentium microarchitecture and dubbed Quark SE, the Curie is the size of a coat button and includes a real-time operating system and on-board Bluetooth Low Energy (LE) radio module and DSP sensor hub. Intel hasn't yet indicated whether it will release a Curie bundle for the maker market, as it's done with its Quark-based Galileo and Edison systems, but the modules will start shipping later this year.



When Pimoroni warns you not to look directly at the LEDs when they're switched on, you know the Unicorn HAT is a serious bit of kit

REVIEW

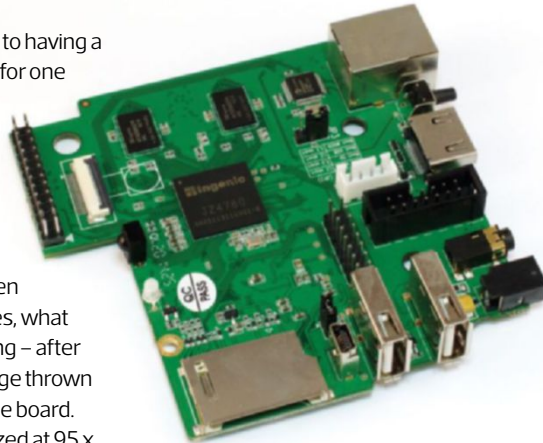
Creator CI20

I've been looking forward to having a go with the Creator CI20 for one simple reason: it's the first single-board computer I've reviewed that uses the MIPS instruction set architecture, in place of the more common ARM or x86 variants.

Created as a partnership between MIPS and Imagination Technologies, what struck me on opening the packaging – after spotting the Imagination-logo badge thrown in as a bonus – was the shape of the board. Not only is it far from credit-card sized at 95 x 100mm, but it also has an odd footprint, which includes a GPIO header sticking out of the side and a strange indent to the board next to the USB ports. Coupled with holes in inexplicable places, it's clear the Creator CI20 didn't start its life as a hobbyist board.

Regardless of its original intention, though, the CI20 is now aimed at hobbyists. Imagination tried to drum up interest in the board with a giveaway late last year, but earned the ire of the maker community when it turned out the company only had a couple of boards. Thankfully, though, the stock troubles are now over.

The kit includes an international 5V, 2A power supply, plus the bare board itself. No SD card is provided, but you don't need one either – the board includes 4GB of on-board NAND flash, although a full-sized SD card slot is available for expansion. By default, a customised variant of Debian Linux is

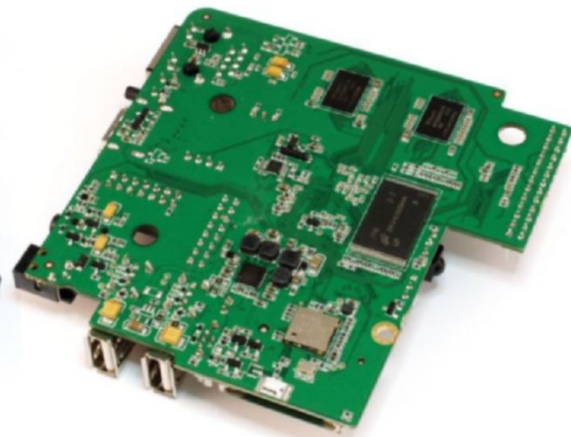


Powered by a MIPS32 processor, the Creator CI20 stands out from the largely ARM-based single-board computer crowd

installed, which can be replaced if required by Android 4.4, or by Gentoo or Yocto builds.

The heart of the Creator CI20 is an Ingenic JZ4780 system-on-chip (SoC) based on the MIPS32 instruction set and offering two cores running at 1.2GHz. Graphics grunt comes from PowerVR SGX540 hardware, but there's a catch: a lack of open-source drivers, a common problem with Imagination's PowerVR series. The company claims to be working on this situation, but graphics-heavy users would likely benefit from a rival board – despite the presence of an HDMI port supporting up to 2K HDMI resolution.

Speaking of resolution, the CI20 has the most awkward and old-fashioned display setting of any board I've used. While having to edit text-based configuration files isn't rare in



The Creator CI20 is clearly designed with a particular application in mind, as evidenced by the bizarre footprint

the single-board computer market, the only way to boot Debian into any resolution except 1080p at 60Hz is to both edit a file and then recompile the kernel – a ridiculous proposition just to change the video output.

There are definite positives to the board's feature set though. While the 1GB of RAM isn't the most generous allocation, it's standard at this price point and the presence of on-board 802.11b/g/n and Bluetooth 4 wireless features is a definite bonus. Wired 10/100Mb/sec Ethernet is also included, along with the aforementioned HDMI output, a 4-pin AC97 analogue audio jack, two USB 2 ports, an infrared receiver, a Raspberry Pi-style GPIO header and a 14-pin JTAG connector for professional programmers.

In use, it's easy to ignore the differences between MIPS and ARM. Debian is the same regardless of the architecture, and ditto for Android. Interestingly, performance is higher than on similarly-clocked ARM-based boards: running SysBench's CPU test on a single core resulted in a 95th percentile time of 13.96ms, far faster than the 51.45ms of a Raspberry Pi or the 29.72ms of a Banana Pi, but lagging behind the significantly more expensive and higher-clocked Jetson TK1's time of 7.31ms.

The Creator CI20 is likely to live or die by its community. While the £50 inc VAT price direct from <http://store.imgtec.com> places it towards the lower end of the market, it will have to work hard to build up a community to rival the likes of the Raspberry Pi. **GPC**

NEWS IN BRIEF

ThingBox brings IoT to the Pi

A new distribution for the Raspberry Pi, dubbed ThingBox, aims to make it easy for developers to create Internet of Things (IoT) projects with the Pi. Based on the Raspbian distribution, ThingBox bundles pre-installed tools, including the drag-and-drop Node-RED programming environment to speed development times while making relatively complex tasks – such as querying remote databases – as accessible as possible to newcomers. The software is released freely under the WTFPL (yes, that stands for what you think it does) and is available to download from <http://thethingbox.io> now.



Gareth Halfacree is the news reporter at www.bit-tech.net, and a keen computer hobbyist who likes to tinker with technology. [@ghalfacree](https://twitter.com/ghalfacree)

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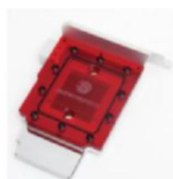
Customised PC

Case mods, tools, techniques, water-cooling gear and everything to do with PC modding

Testing Bitspower's Maximus VII Impact waterblock

I'm a massive fan of mini-ITX, and I was one of the first people to receive the holy grail of small form factor water cooling last year – a full-cover waterblock for Asus' P8Z77-I Deluxe. It's only fairly recently that all the major motherboard manufacturers have taken mini-ITX seriously at the enthusiast level, so it was only a matter of time until waterblock manufacturers stood up and took note too.

Bitspower was first out the door, and its AIZ77ITXD waterblock was stunning. Perhaps the most interesting aspect of the block's design is that it managed to water-cool the P8Z77-I



The AIZ97M7IITX's top section is made from acrylic and is available in black, clear and red (shown here)

Deluxe's vertically mounted VRM daughterboard, as well as various other hotspots on the motherboard. Getting enough airflow to cool these components can be tricky in cramped mini-ITX cases, so being able to water-cool them and get all this heat out of the case via a radiator was a real boon.

The original waterblock for Asus' P8Z77-I Deluxe did have one issue though. Its CPU cooling section used fairly thick cooling fins and, as a result, my CPU – a de-lidded Intel Core i5-3570K overclocked to 4.4GHz with a 1.3V vcore – ran 11°C warmer using the AIZ77ITXD full-cover waterblock compared to an EK Supremacy CPU-only waterblock.

On the plus side, the VRMs and the rest of the motherboard were water-cooled, which was otherwise

impossible without making your own waterblocks (I've been there too). Plus, it looks fantastic and it's very easy to install.

Thankfully, later models of these full-cover waterblocks have improved the CPU cooling section, using thinner, denser cooling fins to maximise the heat transfer surface area, and Bitspower has sent me an example – its new AIZ97M7IITX full-cover waterblock for Asus' Maximus VII Impact.

The top section is made from acrylic and is available in black, clear and red (shown here). The two G1/4in threaded ports are spaced a couple of inches apart, so there are no issues using large compression fittings. Nearly all the parts you'll need to fit it are included in the box too, including thermal pads and screws, although you'll need your own thermal paste for the CPU and chipset.

Removing the Impact's heatsinks is simple, and the instructions are pretty easy to follow. I found it was best to start by attaching the waterblock to the VRM daughterboard, then securing the numerous screws through the underside of the motherboard. You have to detach the Impact's sound card and fan header module to fit the waterblock, but you can reattach them afterwards.

I used a Laing D5 pump, along with a double 120mm-fan radiator, to test the AIZ97M7IITX waterblock, using an Intel Core i5-4690K CPU, which I overclocked to 4.5GHz with a 1.18V vcore. Using an EK Supreme LTX CPU waterblock, I recorded a CPU delta T of 55°C, while an IR thermometer reported the VRM daughterboard pushing out a delta T of 35°C.

With the AIZ97M7IITX waterblock fitted, the CPU temperature was warmer, but only by 5°C – much better than the difference between the



original AIZ77ITXD and a standalone CPU block. In addition, the VRM daughterboard was significantly cooler, with a delta T of 26°C. At the time of going to press, the Bitspower AIZ97M7IITX wasn't yet available in the UK, but overseas retailers www.frozencpu.com (US) and www.highflow.nl (Netherlands) both have it in stock for around £100.

3D Printers and PC modding

I've been fascinated by 3D printers for a while now, but it wasn't until December that I was lucky enough to have one on loan for a few weeks. Made by 3D Systems, the Cube 3 retails for a slightly eye-watering £800, but it's been designed to be easy to use and it's even smaller than a BitFenix Prodigy.

I was already aware of the various online databases where you can download pre-rendered items to print, but I was amazed at the easiness of the whole process.

I then started thinking about bits I could print for my PC. Surprisingly, PC modding and 3D printing haven't mixed all that frequently, with one or two exceptions, but very few modders have used these more affordable

home 3D printers to make parts for their PCs.

I set about looking online at pre-rendered items, and there are certainly a few interesting ideas out there. The first part I printed was a 120mm fan grille, but I also saw hard disk adaptors, fan adaptors and a few other parts; however, there wasn't a vast array of pre-rendered PC parts available to print. For instance, I couldn't find any 140mm fan grilles, and very little in the way of case customisation.

Thankfully, there are a few programs you can use to simply create your own designs. I'll be looking at these programs in a future **Custom PC** feature but, in the meantime, the best software for creating parts quickly is Tinkercad. This browser-based program is brilliant, and I've used it to create all sorts of parts, from motherboard supports for out-of-case testing to tool adaptors. In short, once the price of 3D printers comes down, they'll be incredibly useful for PC modding and plenty of other jobs too.

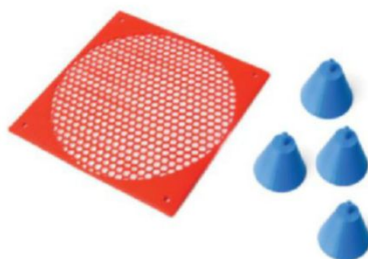
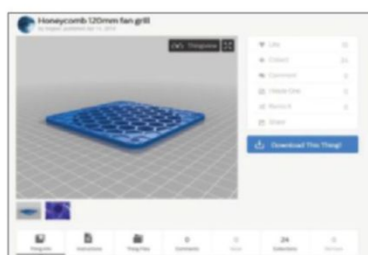
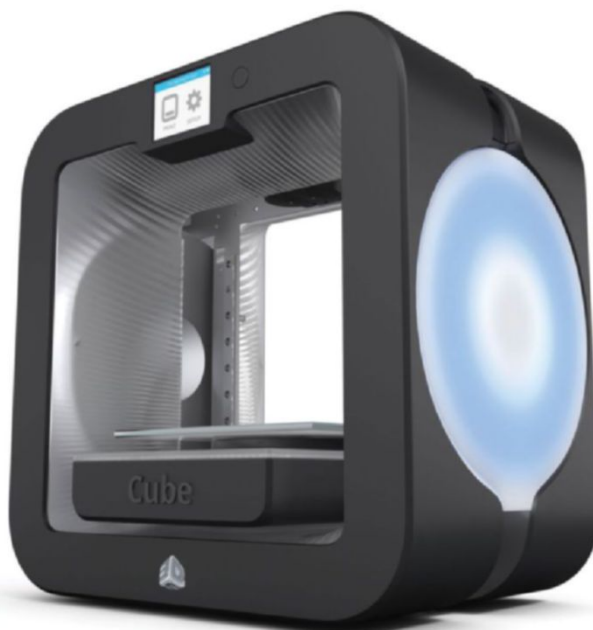
Streamliner by aio

Streamliner is quite possibly my favourite PC mod of 2014, and also the winner of bit-tech's Mod of the Year competition. Incredibly, it started life as a Thermaltake Element S case, but Russian modder aio quickly set about creating all sorts of custom parts to create a PC inspired by mid-20th century car design.

My favourite parts have to be the large chrome exhausts, analogue dials

that work (the speedometer displays the CPU load, for instance) and, of course, the pistons, which again actually move.

Interestingly, Streamliner isn't water-cooled either. There's been a lot of criticism in the modding community about all the projects winning various modding competitions always being water-cooled. Streamliner is a clear example that this simply isn't the case. You can see the whole project log at <http://tinyurl.com/streamliner-mod>, with videos of the build process and the final PC in action at <http://aiologs.net> **GPG**



There's a pre-rendered template available for making a 3D-printed 120mm fan grille



How to

Expand an all-in-one liquid cooler

Fancy adding rigid tubing, a new radiator or more waterblocks to a Raijintek Triton? Antony Leather shows you how it's done

TOTAL PROJECT TIME / 24 HOURS

We've already looked at extending an all-in-one liquid cooler's tubing, and also replacing the coolant with snazzier liquid. However, many of the latest all-in-one liquid coolers are also expandable, enabling you to not only replace or extend the tubing, but the tube fittings as well.

This situation opens up a whole range of possibilities. You could swap out the fittings for ones designed for rigid acrylic tubing, or even fit a larger radiator or add a graphics card to the loop, again using whatever barbs you want. We've used Raijintek's Triton cooler as our test subject, as it has G1/4in port threads and a large reservoir, making it ideal for converting into a customisable water-cooling system.

TOOLS YOU'LL NEED



10/13mm tubing /
www.aquatuning.co.uk



G1/4in fittings /
www.aquatuning.co.uk



BSP 1/4in x 19 TPI
second cut tap /
www.ebay.co.uk



Waterblocks, radiators
and coolant /
www.aquatuning.co.uk



1 / DECIDE ON COOLING AND HARDWARE

You can replace the Triton's tubing and fittings, and add additional radiators or waterblocks. However, the slim double 120mm-fan radiator can only deal with an overclocked CPU and a low-to-mid-range GPU at reasonable noise levels, although its fans are adjustable up to a monstrous 2,600rpm.



2 / EXTEND TUBING

The tubing used with the Triton is almost identical to standard 10/13mm tubing, and we can confirm this tubing works fine and is totally leakproof. It's available in a variety of colours and longer tubes will give you more options when installing the radiator.



3 / REMOVE OLD TUBING AND DRAIN COOLANT

The Triton uses standard compression fittings, so you just need to unscrew the locking rings to remove the tubing. There are four fittings – two on the radiator and two on the pump section that attaches to the motherboard.



4 / MEASURE TUBING LENGTH

We found that an extra 50-100mm of tubing length enabled us to fit the radiator in the front mounts of a range of cases, which wasn't possible before. Check your own case to see how much tubing you need to reach your desired radiator location, then cut the tubing to size.



5 / FIT NEW TUBING

Push the tubing over the barb – it should fit fairly tightly – then push the locking ring over the other end before screwing it onto the barb. It will eventually tighten up as it grips the tubing, creating a tight seal.



6 / SWAP OUT FITTINGS

Both the pump and radiator use standard G1/4in threaded ports, which will be compatible with nearly all aftermarket fittings, including the fittings for rigid acrylic tubing shown here. It's slightly trickier to replace the fittings than just the tubing though.



7 / USE ADJUSTABLE WRENCH

The Triton's fittings have small flattened edges, so an adjustable wrench is the best tool for removing them. Be warned though – Rajjintek has used thread lock (a material used to prevent parts from being unscrewed) on the fittings, so they need a lot of force to get them loose.



8 / APPLY WD40

You may find that spraying a lubricant such as WD40 or GT85 helps the barb to continue moving as you unscrew it. Spray every few turns to allow it to get into the thread. The adjustable wrench was the only tool we found that worked for this job – even a mole grip couldn't work the fittings free.



9 / DIG OUT THREAD LOCK

It's likely the thread lock will prevent you from installing the new fittings too, but you can remove it using a couple of methods. One of our bars only had a little thread lock on it, and we managed to work this out of the barb with a knife before our fitting could be screwed into the vacant port.



10 / USE A TAP TO CLEAR OUT THREAD LOCK

The other port was caked in thread lock, but a G1/4in tap made short work of it and cleared out the thread so that our fitting screwed into place easily. These taps cost around £5, but are essential if your threads look like the one in the above photo.



11 / FIT NEW BARBS

As you can see, these Primochill Revolver fittings for rigid acrylic tubing fit perfectly. Most fittings now use rubber O-rings to make a seal between the thread and the base of the fitting, so make sure this ring is properly seated.



12 / ADD WATERBLOCKS

You can also add a GPU or chipset waterblock to your loop, but if that's your plan, it's also best to replace the radiator, as the Triton's radiator has an aluminium core. Mixing a copper waterblock, especially one that hasn't been coated, with aluminium can lead to galvanic corrosion.



13 / REMOVE RADIATOR

Adding another waterblock to the loop will likely necessitate the need for a larger radiator anyway. We recommend using a 45mm or 60mm-thick double 120mm-fan radiator to cope with an overclocked CPU and mid-range graphics card.



14 / ADD NEW RADIATOR

You can now add your new radiator. It might sound logical to have the waterblock after the radiator, but the coolant temperature equalises around the loop anyway, making the order of parts in the loop irrelevant, especially as the reservoir, CPU waterblock and pump are housed in a single unit.



15 / FILL BLEED SYSTEM

You can now install and bleed the system. This pump isn't powerful enough to fill the system on its own, so you'll need to tip the reservoir to fill the loop with your coolant. Even with a large radiator and GPU waterblock, though, the pump was powerful enough to pump the coolant around our loop. **GPC**



bitGamer

www.bit-gamer.net

**YOU'VE GOT THE HARDWARE,
NOW FIND OUT HOW TO USE IT**



XBOX 360 • PLAYSTATION 3 • PC • Handhelds

How to Install a fanless PSU

Want to create a silent system?
Antony Leather shows you how to
install a fanless picoPSU

TOTAL PROJECT TIME / 3 HOURS

Thanks to ever more efficient components, many modern PCs draw fairly small amounts of power – less than 150W under full load in some cases. Accordingly, many PSU manufacturers now allow some of their units to switch off the cooling fan under light loads. Some, such as Seasonic, offer entirely fanless PSUs too, although they're still quite expensive.

There's another way to get fanless power though. PicoPSUs use external power adaptors, such as the ones that power laptops, but connect to a standard ATX motherboard power connector. They're ideal for powering small, low-power PCs such as HTPCs, as they take up very little space and they're silent. However, very few cases offer the right mounting holes for picoPSUs. In this guide, we'll install a picoPSU into a standard ATX case, and also see what you gain from opting for a more powerful fanless ATX PSU instead.

TOOLS YOU'LL NEED



PicoPSU and power adaptor /
www.linitx.com



Drill and drill bit /
Most hardware stores



Power meter /
www.ebay.co.uk



1 / CONSIDER A FANLESS ATX PSU

Fanless PSUs were once risky, but thanks to modern efficiency, big names such as Seasonic now offer solid, low-wattage fanless PSUs. However, you'll probably be limited to just 400-500W, and only one or two 16x PCI-E as with Seasonic's X-400, plus these units cost a lot more than picoPSUs.



2 / FIND YOUR PC'S MAXIMUM POWER DRAW

Before you decide on a PSU, confirm just how much power your PC will use under load. This figure can enable you to ascertain whether you need a powerful fanless ATX PSU, or if you can use a smaller, cheaper picoPSU.



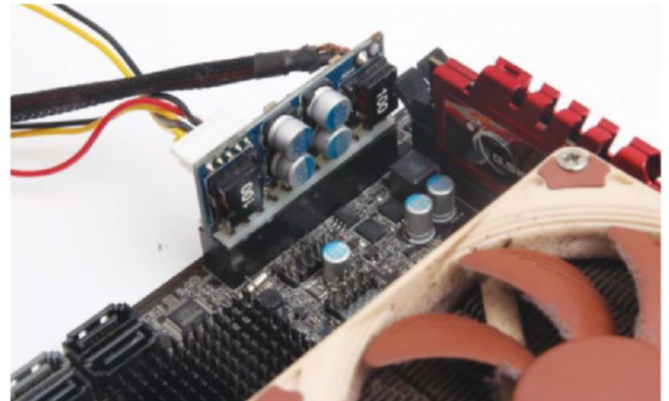
3 / RUN PRIME95 AND UNIGINE VALLEY

Download and install Prime95 (<http://files.extremeoverclocking.com>) and if you have a discrete GPU, Unigine's Valley benchmark too (<https://unigine.com>). Run them concurrently – Prime95 using the smallfft test and Unigine Valley using maximum settings.



4 / RECORD PEAK POWER

Use a mains power meter (they're fairly cheap on eBay and Amazon) to measure the peak power draw. Some 120W picoPSUs are reasonably priced, but they can get expensive above this figure, so if your PC draws more than or close to 120W, you may be better off with a fanless ATX PSU.



5 / INSTALL PICOPSU

If you're using the picoPSU in a standard PC case, you'll need to cut a hole for the power cable to pass through to the adaptor on the outside. Start by installing the picoPSU's ATX power connector in the motherboard's socket. Now is also a good time to test that the PSU works properly.



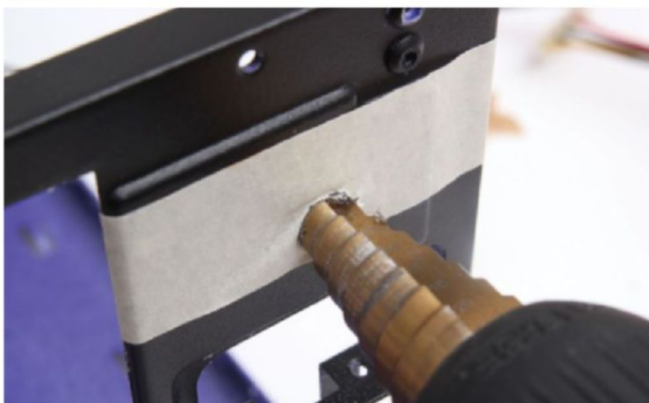
6 / MEASURE UP FOR EXTERNAL POWER SOCKET

The picoPSU cable needs to reach a case panel – ideally the rear one. Assess where it will be best to mount the cable so it's easily accessible from the outside and simple to route on the inside. You can route the cable through the vacant ATX PSU slot, but it's better to mount it properly.



7 / MARK UP HOLE

Place masking tape over the area to be drilled then mark up the drill hole. Now measure the power connector thread to see what size of hole you need to drill.



8 / DRILL HOLE AND CLEAN CASE

Remove any hardware from your PC case, and then drill the hole, before cleaning the case of any metal fragments. Our connector needed a drill hole of 8mm. It will include a locking ring, so you just need to allow the threaded section to pass through the hole, and you can then lock it in place.



9 / INSTALL POWER SOCKET

Reinstall your PC hardware, and connect the picoPSU to the motherboard before finally mounting the power socket. The cables are often only held on to the socket by solder, so make sure the cables aren't under too much stress on their way to the rear panel. **GPC**

Readers' Drives

The Green Way

Inspired by Nvidia's distinctive green branding, Etienne Hostein decided to build his very first modding project

CPC: What originally inspired you to build The Green Way?

Etienne: As I've been an Nvidia fan for many years, I wanted to create a mod dedicated to the reference design of its high-end cards.

Furthermore, I was getting a little tired of seeing all these red and black PCs – Asus started this trend among gamers with its ROG products, and other brands have followed almost naturally. As Nvidia is represented by the colour green, I chose to highlight this colour in my mod.

The name 'The Green Way' comes from Nvidia's slogan 'The way it's meant to be played' and again from the colour linked to Nvidia.

CPC: What specs did you choose, and why?

Etienne: The objective of this project was to create a setup based on a 3-way SLI graphics configuration, so I chose the best affordable parts (in my opinion) to achieve this goal. I chose a Gigabyte G1 Sniper 5 motherboard firstly

for its colours, but also because the PCI-E slot configuration would allow me to connect three GTX 780 cards side by side with a single SLI bridge connector.

Likewise, I chose to use 16GB of Corsair green Vengeance low-profile RAM to colour-match the rest of the system, along with a Core i7-4770K, which is the best CPU from the first generation of Intel's Haswell line-up.

There's also a Kingston HyperX SSD, and a RAID 1 hard drive setup. I almost lost all my data this year when the PCB of my old hard drive shorted out – I had to replace it, and I wanted to avoid this situation happening again, which is why I have the mirrored RAID array.

CPC: What other mods have you built?

Etienne: I discovered modding in 2013, thanks to the LDLC Modding Trophy competition, but I didn't get really interested in it until 2014. That's when I started to read many project logs, study the tutorials posted by modders and realised that modding could be within reach of my skills too. I then decided to create The Green Way, which is my first mod.

CPC: What difficulties did you come across?

Etienne: As The Green Way was my first mod, I would say that each step was difficult (sleeving and braiding cables, cutting aluminium plates, painting, lighting up Plexiglas plates and so on). To help me, I had access to various specialised forums, but I also benefitted from the advice of another French modder, K-limes, who won a trophy in the 2103 LDLC Modding Trophy competition. I didn't know him personally, but I started to get to know him on a forum. I told him



about my desire to get into modding, and he then made himself available whenever I needed help – I now consider him to be a little like my godfather.

CPC: What materials did you use?

Etienne: The main materials I used were aluminium and Plexiglas. The aluminium is soft metal that's easy to work with, so I used it to make part of the top graphics card backplate and the front 5.25in plate that discreetly integrates a fan controller. Aluminium was also used to create the box at the bottom of the case that houses the PSU and water-cooling parts. The Plexiglas was used for its light scattering properties, so I used it as the basis for the graphics card backplate and the Nvidia logo on the front of the case.

CPC: What tools and machinery did you use?

Etienne: When I first started the mod, the only tools I owned were a Dremel and a drill. As I live in an apartment, I didn't have any workspace either, so I occupied my



/MEET THY MAKER

Name Etienne Hostein (Hostiti)

Age 32

Location Besançon, France

Occupation Psychiatric nurse

Main uses for PC Gaming, CAD, Internet

Likes Sleeping for eight hours in a row, Burgundy wine, French cheese, terrine toast for breakfast

Dislikes Seeing snow falling before I drive to work, my daughter waking me up at 7am when she's on holiday, being woken up by my neighbour's drill



in-laws' garage (who I also thank!), so I had access to some additional tools. My mod is quite simple, though, so I didn't need many additional tools – I used specific files for working with aluminium, a rivet gun and some paint.

CPC: What media interest has the project attracted?

Etienne: To my knowledge, three French websites have written articles about my mod (www.modding.fr, www.cowcotland.com and <http://ocaholic.ch>), and Custom PC is the first paper media to be interested in my work.

SYSTEM SPECS

CPU Intel Core i7-4770K

Graphics card 3 x Nvidia GeForce GTX 780

Case Corsair Obsidian 750D

Memory 16GB Corsair Vengeance LP 1,600MHz

Motherboard Gigabyte G1.Sniper 5

Storage 120GB Kingston HyperX SSDs, 2 x 1TB Western Digital Red (5,400rpm)

hard drives in RAID 1 configuration

PSU Corsair AX1200i

Cooling Swiftech MCP 355 pump, EK-XTOP DDC Plexi pump top, Swiftech Apogee waterblock, DocMicro 280 Slim radiator, EK Multioption X2 Res 100 reservoir, EK 10/12 + EK HD 10/12 tubing, Mayhems Green Mint Pastel coolant



However, Facebook proved to be an incredible way to distribute my work on the Web – my photos were shared hundreds of times in dozens of different countries.

CPC: How long did the build process take?

Etienne: Before starting work on the mod, I'd spent a long time

considering the components I wanted to use. However, I never developed a plan – I had a clear idea of what I wanted to create, but at the beginning, I couldn't imagine how it would look when it was finished. It was after the purchase of the Corsair 750D case that I finally embarked on the construction of the mod. From the moment the case arrived, I could define the aesthetics of the mod more precisely, and imagine the changes I could make. I finally started work on the project in September 2014, and I finished it in December. Over those three months, I worked on it for an average time of 15 hours per week.

CPC: What have you learned from the build process?

Etienne: I learned that patience is essential for modding and that, even if you don't own all the right tools, every minute spent working on a mod amplifies the satisfaction

of seeing it take shape. Also, it's important to never give up. You don't always get the desired results, and sometimes it's necessary to change your plans in order to adapt to unexpected developments, whether they concern technical aspects, aesthetic appearance or simply your budget.

CPC: Are you happy with the end result, and is there anything you'd do differently if you built it again?

Etienne: As The Green Way was my first mod, I wanted to perform rather simple and accessible modifications – I didn't want it to get too complicated, or I'd be afraid it would never get finished. However, I'm satisfied with the end result, especially given the success it's had online. If I built it again, I think I would spend more time on the water-cooling parts and other small details, such as using LEDs and stickers, painting the USB 3 ports green and so on. **GPB**

BE A WINNER

To enter your machine for possible inclusion in Readers' Drives, your mod needs to be fully working and, ideally, finished based in the UK. Simply log on to www.bit-tech.net and head over to the forums. Once you're there, post a write-up of your mod, along with some pics, in the Project Logs forum. Make sure you read the relevant rules and advice sticky threads before you post. The best entrant each month will be featured here, where we'll print your photos of your project and also interview you about the build process. Fame isn't the only prize; you'll also get your hands on a fabulous selection of prizes – see the opposite page for details.

Win all these prizes!

We've teamed up with some of the world's leading PC manufacturers and retailers to offer this great range of prizes to each lucky Readers' Drives winner. If your creation is featured in the magazine then you'll walk away with all of the prizes listed on this page, so get in your entries!

Corsair graphite Series 230T case and RM 550w Modular power supply

TOTAL VALUE £150 inc VAT / **MANUFACTURER** www.corsair.com

Corsair believes that a great PC starts with a great case.

The Corsair Graphite Series 230T is a compact expression of this core philosophy. With stylish looks and a choice of three different colours, it packs in a remarkable number of features to provide builders with tonnes of room for expansion and amazing cooling potential. Like all Corsair cases, it's built using the finest materials and finished to the highest standards, so it will withstand several years of upgrades. Plus, to make sure it stand out from the crowd, the 230T features Corsair's new Air Series LED high-airflow fans, providing distinctive lighting with low-noise, high-airflow cooling.

Just as a quality case is essential to building a quality PC, a high-performance, a high-quality power supply is also a vital ingredient. The all new RM series has been built from the ground-up to deliver unmatched reliability alongside 80Plus Gold efficiency, and all with the absolute minimum of noise. It uses specially optimised quality parts to reduce sound at the component level, and it's completely silent below 40 per cent load, thanks to its Zero RPM fan mode. It's also fully modular, allowing for the maximum amount of flexibility during installation. With a Corsair Graphite 230T case and an RM 550W Modular power supply at the heart of your build, you'll have the foundations for a truly awesome gaming machine.



Mayhems coolant and dyes

VALUE £50 inc VAT /

MANUFACTURER www.mayhems.co.uk



Cooling performance is only one part of the equation when it comes to kitting out your rig with custom water-cooling gear. The other major bonus is that all those tubes and gleaming fittings just make your PC look damn sexy, and they look even better when they're pumped full of fancy coloured coolant. As such, we're particularly pleased to have the folks at Mayhems now on board with Readers' Drives; they're currently offering two 1-litre bottles of Mayhems' Pastel Ice White coolant, along with a selection of five dyes, so you can choose the colour that best complements your PC. Check out the blue coolant in our own mini PC mod on the cover of Issue 109 for an example of what's possible with some Mayhems coloured coolant.

Phobya Modding Kit

VALUE £50 inc VAT **MANUFACTURER** www.phobya.com, www.aqua-tuning.co.uk

The Phobya modding kit is designed with the modder in mind, offering great value for money and quality products. The kit includes Nano-G 12 Silent Waterproof 1,500rpm multi-option fans, which use an innovative fan-blade design. As standard, the fans include braided black cables to keep your case looking as neat as possible. The fans are also supplied with a special cable that lets you run the fan at 5V rather than 12V, reducing the noise emitted in order to help you to build a silent system.

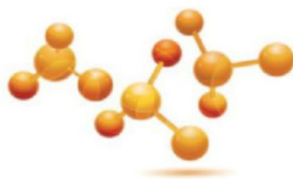
The kit also includes the 60cm Phobya 3-pin Molex to 4x 3-pin Molex Y-cable. This pre-

braided extension cable gives you extra routing options in your case, and it also enables you to run up to four fans from one compatible

motherboard header. Meanwhile, the Phobya SATA 3 cables included in the kit offer the same great quality braiding as the rest of the Phobya range, while also securing your connection with latched connectors.

As well as this, the kit includes the Phobya SlimGuide Controller, which gives you the option to vary the speed of other fans in your case, while the Phobya TwinLEDs let you shine a light on your mods.





Folding@Home

Join our folding team and help medical research

Folding in a web browser

Simon Treadaway guides you through Google's Portable Native Client

You no longer have to run a separate, dedicated Windows app to get your PC folding, thanks to some clever technology from Google. As such, Folding@home can now get access to all your PC's computing power using nothing other than the Google Chrome web browser, courtesy of a new technology provided by Google called Portable Native Client (PNaCl).

To put it simply, Portable Native Client takes high-performance native code that uses a device's full hardware capabilities, but then runs it in a browser tab, including features such as SIMD support and the ability to process multiple threads.

In order to get folding in a browser, you need to do the following.

- 1 Install Google's Chrome browser on Windows, Mac OS or Linux (www.google.com/chrome)
- 2 Install the Folding@home app

WHAT IS FOLDING?

Folding@home uses the spare processing cycles from your PC's CPU and graphics cards for medical research. You can download the client from <http://folding.stanford.edu> and our team's ID is 35947. Once you pass a significant milestone, you'll get your name in the mag. You can also discuss folding with us and other readers on the www.bit-tech.net forums.



You can run Folding@home in a Chrome browser tab, complete with multiple threads pushed to their limits

from the Chrome Web Store (<http://bit.ly/fahwebapp>)

- 3 Launch the Folding@home Chrome app
- 4 Configure the client with a username – use your existing one if you're already folding for the Custom PC team

Set up a passkey to get bonus points

- 5 Enter the team number 35947 to fold for the Custom PC folding team
- 6 Set up a passkey to get bonus points (<http://bit.ly/fahpasskey>)

You don't even need to install the Chrome Folding@home app if you don't want to do so. Take your web browser (Chrome only) over to <http://folding.stanford.edu/nacl>, and you can get folding in your browser straight away.

MILESTONES THIS MONTH

USERNAME	POINTS MILESTONE	USERNAME	POINTS MILESTONE	USERNAME	POINTS MILESTONE	USERNAME	POINTS MILESTONE
Maglor	20000	robertmather	500000	Bedders	4000000	mashspud	10000000
LynnRFlye	30000	ssjandu	500000	Dave_Laffin	4000000	Rhddrk	10000000
Petersheed	30000	StuManchu	500000	Mem	4000000	Origami_Tsuki	20000000
ZardozSpeaks	30000	Catflaps	600000	Portchylad	4000000	Vaio	20000000
Anonymous	30000	Sparrowhawk	600000	Simlec	4000000	kirk_1701	30000000
reidmarc	50000	BigD-lite	700000	Skidder	4000000	peete	30000000
BrawnyFanta	80000	DavidAG	700000	Allan_Smith	5000000	8Core	50000000
carbontwelve	80000	Flowwwie	700000	awstcomputers	5000000	mmorr	50000000
Screener27	90000	Pickles	800000	toothytech	5000000	Desertbaker	80000000
Bleakknave	100000	conficient	1000000	MattEngr	6000000	Laguna2012	80000000
Ganey	100000	ejhunter	1000000	Orac	6000000	PC_Rich	200000000
HolyCow	100000	Hagrids-Desktop-18	1000000	HHComputers	7000000	StreetSam	400000000
i7icemonkey93	100000	Philip_King	1000000	quelluomo1	7000000	DocJonz	900000000
KONRAD	100000	TrekkieStu	1000000	Little_Willie	9000000	Nelio	2000000000
LSB86	100000	Brentwood-Computers.com	2000000	BeezaBob	10000000		
jammyd22	200000	Lord_of_the_Nazgul	2000000				
lilmatt157	200000	only_happy	2000000				
MacabreWolf	200000	Semmy	2000000				
ShakyBakey	200000	AAM20007	3000000				
Aedin	300000	GreenDemon360	3000000				
andboo1	300000	Grimpeeper	3000000				
BondyBoy	300000	ittoms	3000000				
Hateboy	300000	JimmyMcRees	3000000				
varnis	300000	kiiight	3000000				
Sonic67	400000	madmatt1980	3000000				
GJBriggs	500000						

THE NEXT OVERTAKE

WORLD RANK	TEAM NAME	POINTS	DAILY POINTS AVERAGE	TIME UNTIL OVERTAKE
6	TSC! Russia	14,800,538,310	15,274,741	10.7 months
8	Maximum PC Magazine	13,872,072,935	14,163,875	5.2 days
9	Custom PC & bit-tech	13,851,084,080	18,224,377	0

TOP 20 OVERALL

RANK	USERNAME	POINTS	WORK UNITS
1	Nelio	2,100,325,456	97,638
2	DocJonz	905,769,075	168,706
3	coolamasta	645,166,747	155,555
4	Scorpuk	455,877,795	12,405
5	Dave_Goodchild	454,677,435	116,948
6	StreetSam	414,694,332	85,855
7	piers_newbold	329,141,416	33,042
8	johnim	250,825,389	77,408
9	phoenicis	250,044,587	95,660
10	Wallace	212,477,027	6,204
11	zz9pzza	211,014,628	15,794
12	PC_Rich	210,636,223	68,035
13	Slavcho	197,650,299	30,786
14	Lordsoth	179,053,135	88,032
15	The_M2B	170,796,603	52,490
16	Ben_Lamb	166,053,146	2,891
17	Christopher_N_Lewis	152,366,735	35,848
18	Lizard	131,878,662	60,132
19	fir3x	124,472,425	19,907
20	TheFlipside	120,150,031	18,148

TOP 20 PRODUCERS

RANK	USERNAME	DAILY POINTS AVERAGE	OVERALL SCORE
1	Nelio	5,580,280	2,100,325,456
2	DocJonz	1,139,649	905,769,075
3	StreetSam	1,139,115	414,694,332
4	piers_newbold	822,155	329,141,416
5	HHComputers	773,433	7,028,665
6	Scorpuk	630,143	455,877,795
7	coolamasta	619,660	645,166,747
8	johnim	587,532	250,825,389
9	The_M2B	468,359	170,796,603
10	PC_Rich	451,687	210,636,223
11	Lordsoth	424,499	179,053,135
12	Laguna2012	420,740	89,018,058
13	Slavcho	409,041	197,650,299
14	Desertbaker	391,890	87,474,253
15	mmorr	264,724	53,799,071
16	TheFlipside	241,502	120,150,031
17	apeman556	222,435	59,459,626
18	Cmaxx	165,893	39,834,450
19	Roveel	158,493	37,455,220
20	mashspud	157,491	13,453,940



JAMES GORBOLD / HARDWARE ACCELERATED

WINDOW OF CHANGE

Rather than obstructing you from doing what you want, Windows 10 allows you to access your apps and data in your chosen way, says James Gorbold

A new version of Windows always generates a lot of press coverage and, with the exception of Windows 8, it's historically created a bump in PC sales too. However, Windows 10 is of particular interest after Windows 8 proved so unpopular.

You could easily fill an entire magazine the length of **Custom PC** with a list of Windows 8's faults, but to my mind, they can all be neatly summed up in one phrase: 'Windows 8 got in the way of users.' I've come to this conclusion because, at a fundamental level, an OS should simply be a tool that allows you to access your applications and data in the way that you want.

It can neatly be broken down into two fundamentals, the interface itself and the number and quality of applications available. The latter is a key point and explains why, despite being technically superior in many ways, Linux has never offered a serious challenge to Windows – it simply lacks a broad enough suite of applications and games to attract users.

In the early days of computing, OS design was comparatively easy, as people only expected to run a single application at a time, a task that could be simply accomplished by typing the path of the application and its name, or in the case of more technical users, by creating a batch file to do this job for you.

However, as the graphical user interface started to take over from command-line-based operating systems in the mid-1990s, and provided the ability to easily run multiple applications at the same time, the interface of the OS became more important than its performance. For example, even though Windows 8 loads applications faster than Windows 7, and it boots quicker

too, the interface still meant it took longer for many people to do what they wanted.

But in a U-turn so massive that you can almost hear the tyres squealing in Microsoft's Redmond HQ all the way over in the UK, Windows 10 no longer forces you to adjust your way of thinking to a tile-based interface. Instead, it offers you a multitude of choices.

For traditionalists who have grown used to the Start Menu, a fundamental element of the Windows GUI since Windows 95, this U-turn sees the return of the Start Menu in Windows 10.

The new, improved Start Menu is a big step in the right direction, and it's accompanied by key new features, such as additional levels of Snap and support for virtual desktops, two features alone that will have a huge impact on multitasking. I'll be able to run all the different applications I need in my day job without investing in a huge monitor array and a new neck every time I swivel my head.

In keeping with this new strategy, rather than abandoning the Metro Start Screen introduced by Windows 8, Windows 10 retains this alternative style of control, but keeps it in reserve as an option rather than a mandatory choice. It's a smart move – while I still find the Start Screen incredibly unintuitive at times, it's undoubtedly superior to using the Start Menu on a touch-screen device.

While Windows 8.1 laid some of the groundwork for this dual GUI design, Windows 8.1 still felt like two operating systems badly stitched together. In contrast, Windows 10 doesn't suffer from this same problem and as such, I'm genuinely looking forward to installing Windows 10 on my PCs later this year. **GPG**

Despite being technically superior in many ways, Linux has never seriously challenged Windows

James Gorbold has been building, tweaking and overclocking PCs ever since the 1980s. He now helps Scan Computers to develop new systems.

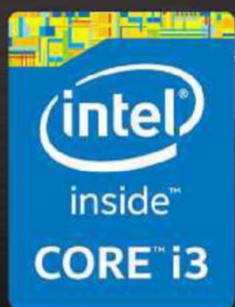
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